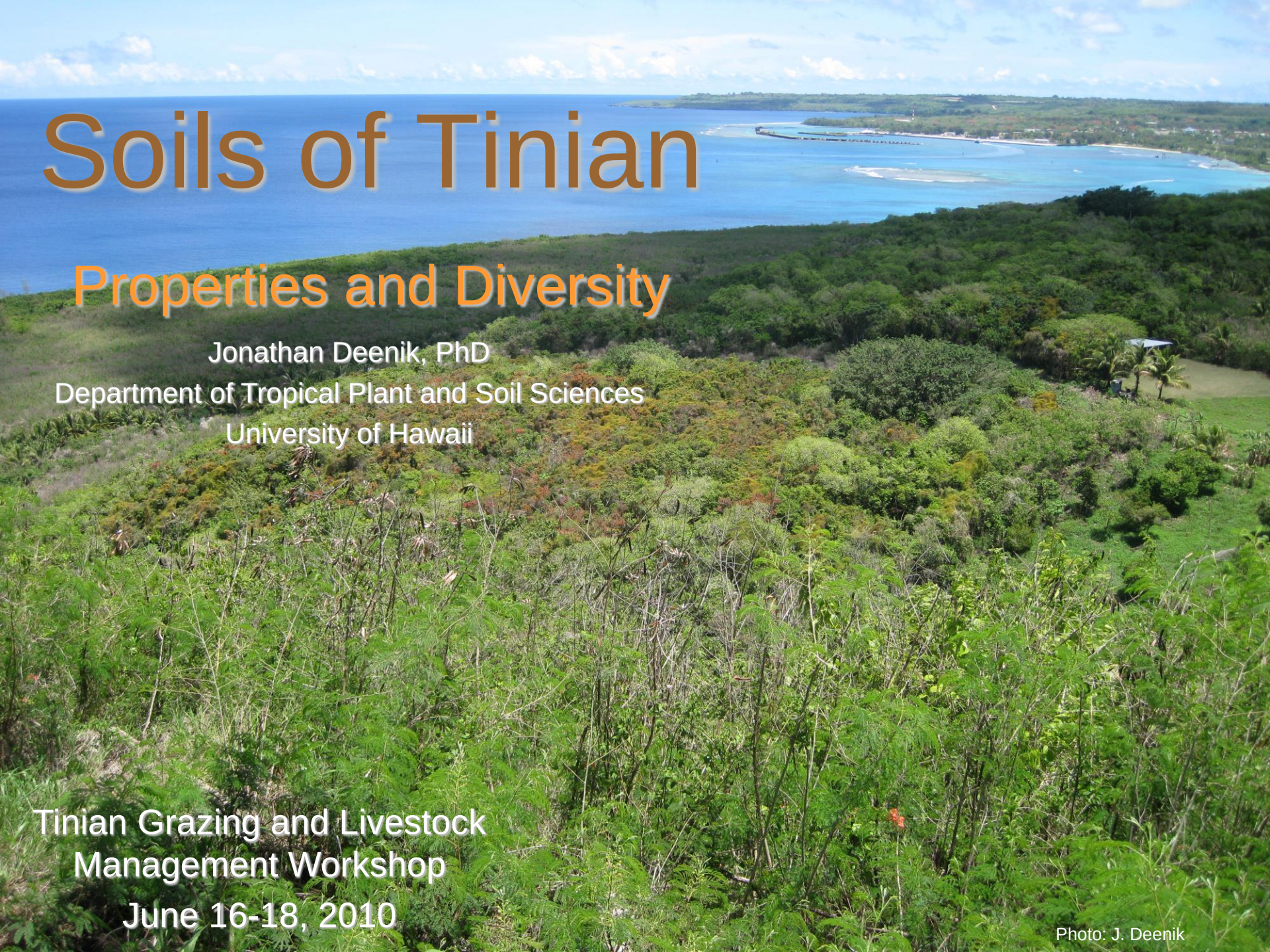

Soils of Tinian

Properties and Diversity

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Department of Tropical Plant and Soil Sciences
University of Hawaii

Tinian Grazing and Livestock Management Workshop
June 16-18, 2010

Photo: J. Deenik

Outline

- Soil formation
- Importance of Soil
- Soil Basics
  - Soil composition
  - Texture and clay minerals
  - Soil pH and nutrient availability
  - Soil organic matter
- Soil distribution on Tinian

Soil Formation

Soil = *f*(PM, Cl, O, R, T)

<u>Factors</u>:

PM = parent material (rocks)

Cl = climate (precipitation and temperature)

O = organisms (plants and animals)

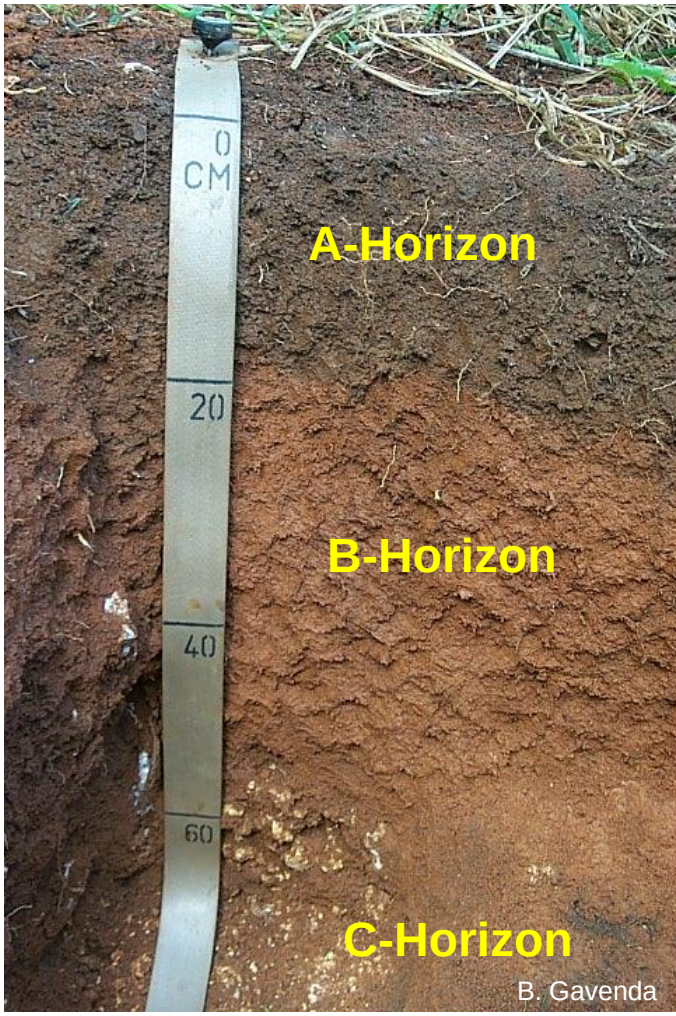
R = relief (topography, drainage)

T = time

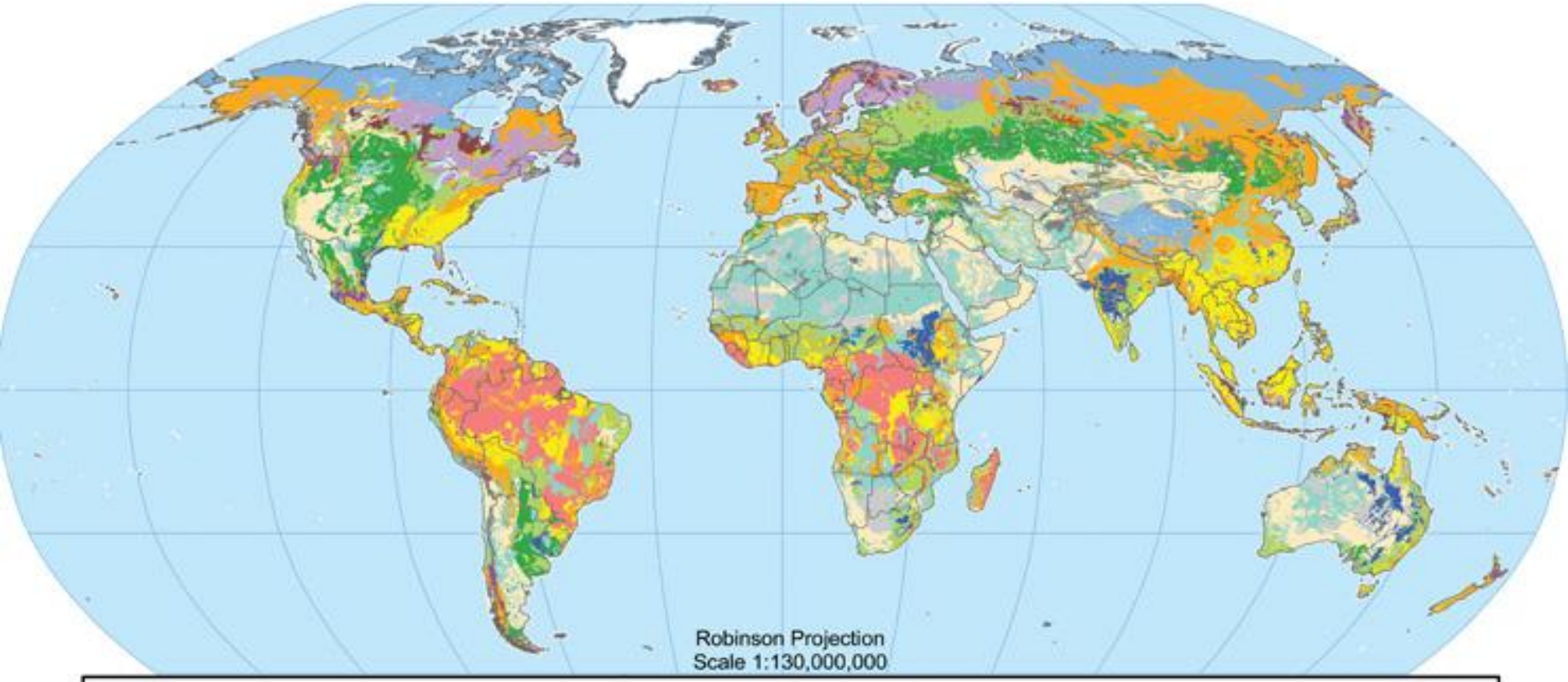
Soil Formation

Processes:

1. Additions
   - Water, organic matter, sediment
2. Losses
   - soluble compounds, erosion
3. Transformations
   - Organic matter to humus
   - Primary minerals to clay minerals
4. Translocations
   - Soluble compounds
   - Clays



Global Soil Regions



Soil Orders

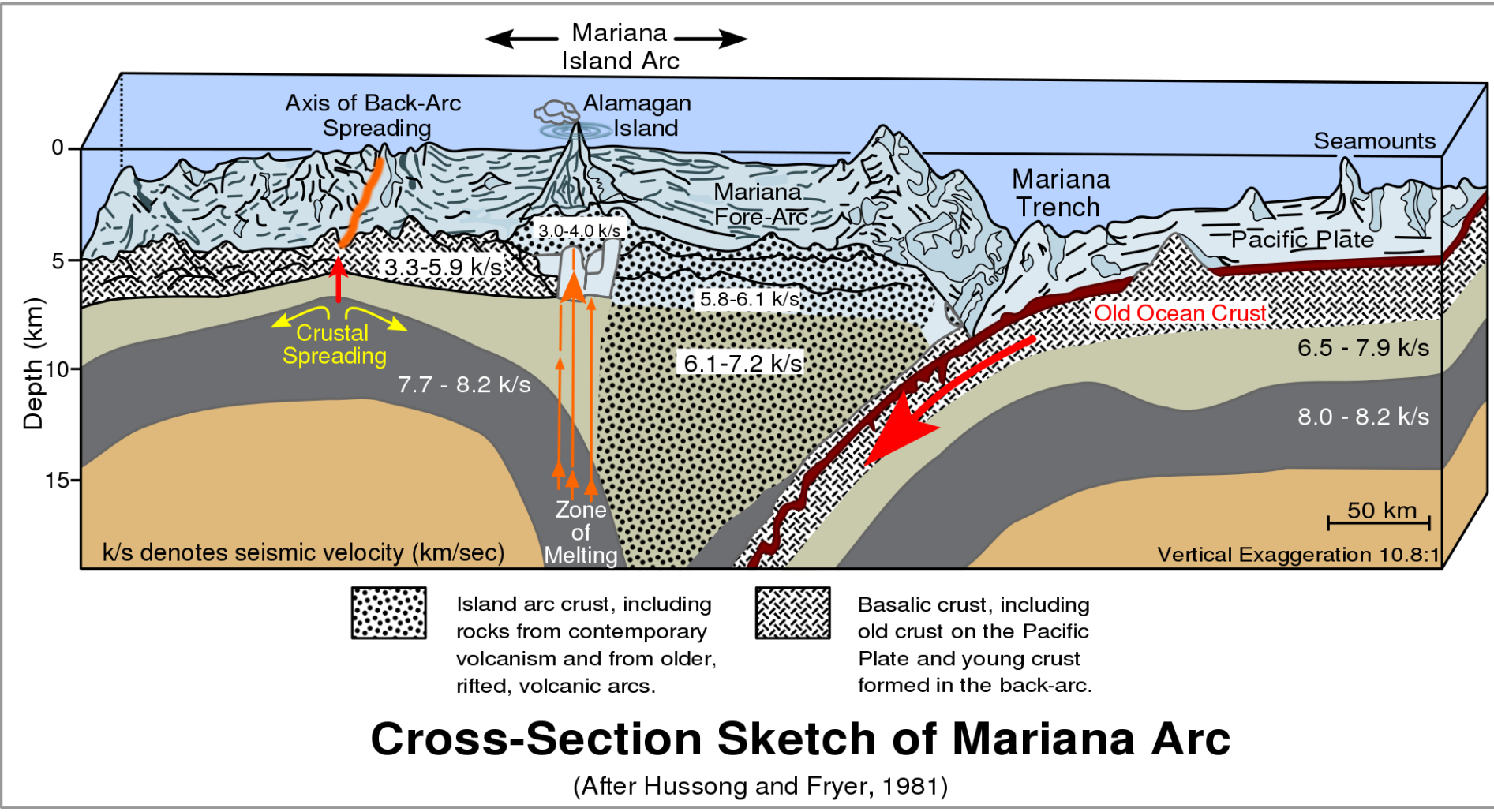
Alfisols	Entisols	Inceptisols	Spodosols	Rocky Land
Andisols	Gelisols	Mollisols	Ultisols	Shifting Sand
Aridisols	Histosols	Oxisols	Vertisols	Ice/Glacier

USDA NRCS US Department of Agriculture
Natural Resources
Conservation Service

Soil Survey Division
World Soil Resources
soils.usda.gov/use/worldsoils

November 2005

Island Formation

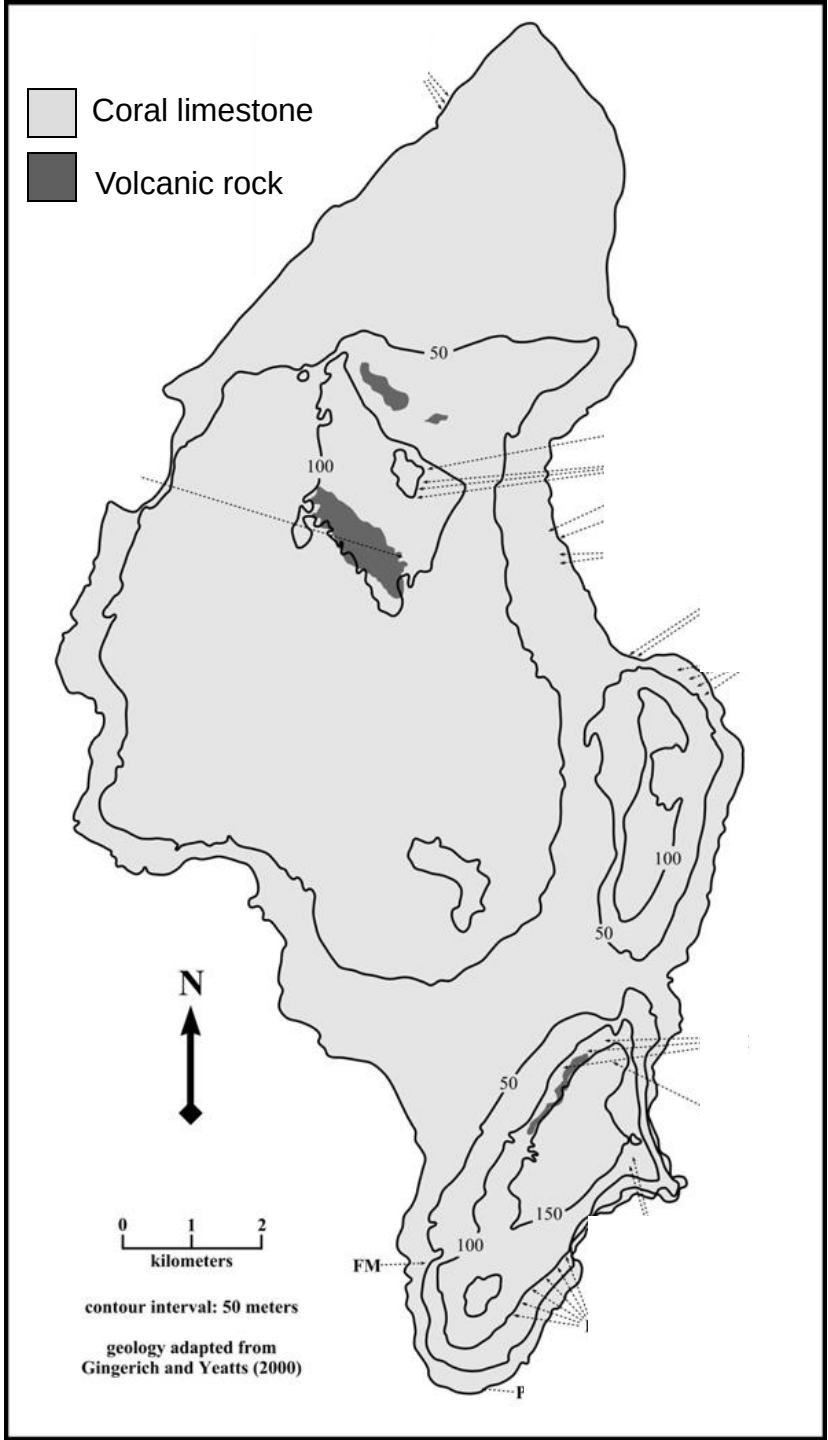


Cross-Section Sketch of Mariana Arc

(After Hussong and Fryer, 1981)

Parent Material on Tinian

- Parent material is mostly coral limestone with small exposures of volcanic rock



Soil Formation on Rota

1. Dissolution of $CaCO_3$ limestone, and soil forms from impurities
   - 30-100 ft of limestone to produce 1 ft of soil
2. Deposition of dust blown from Asian deserts, and soils form from weathering of the dust

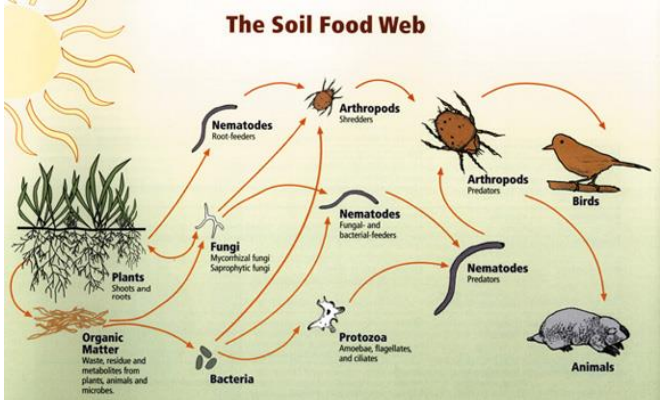
Saipan soil series

B. Gavenda

5 Functions of Soil

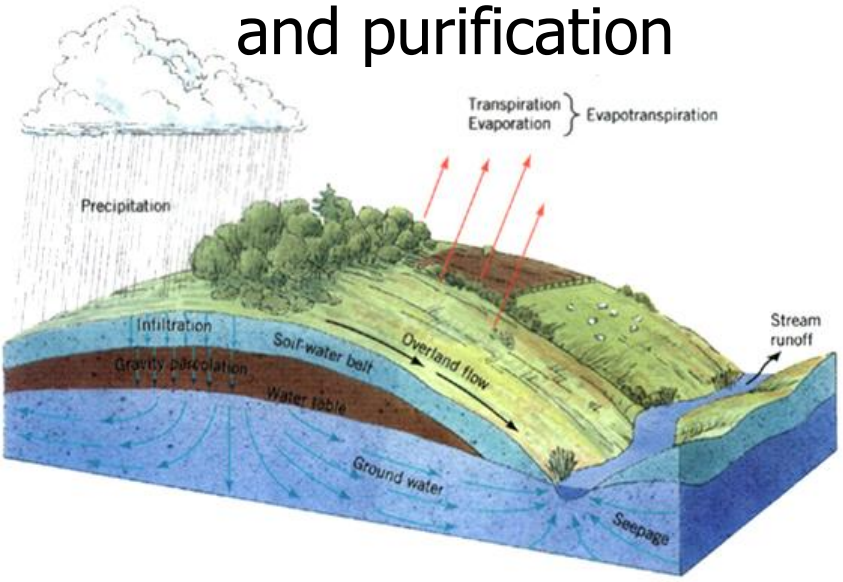
Medium for Plant growth

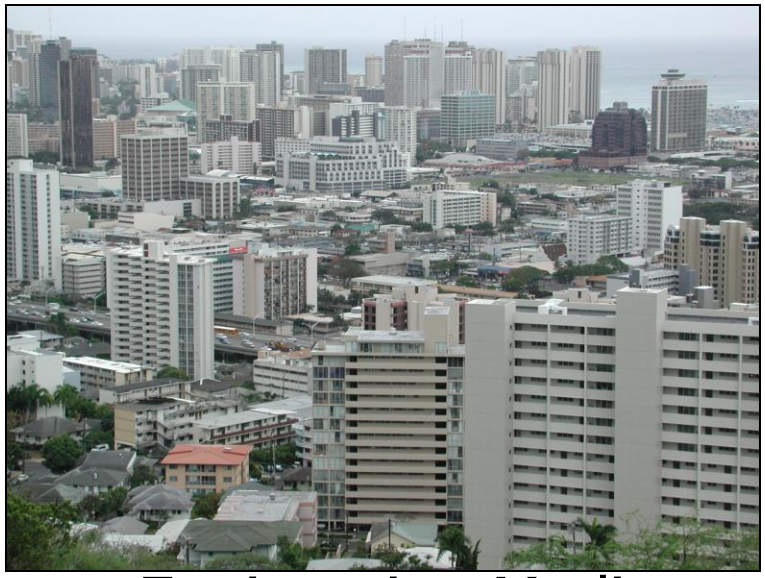
Habitat for Soil organisms



Recycling system

Water supply and purification

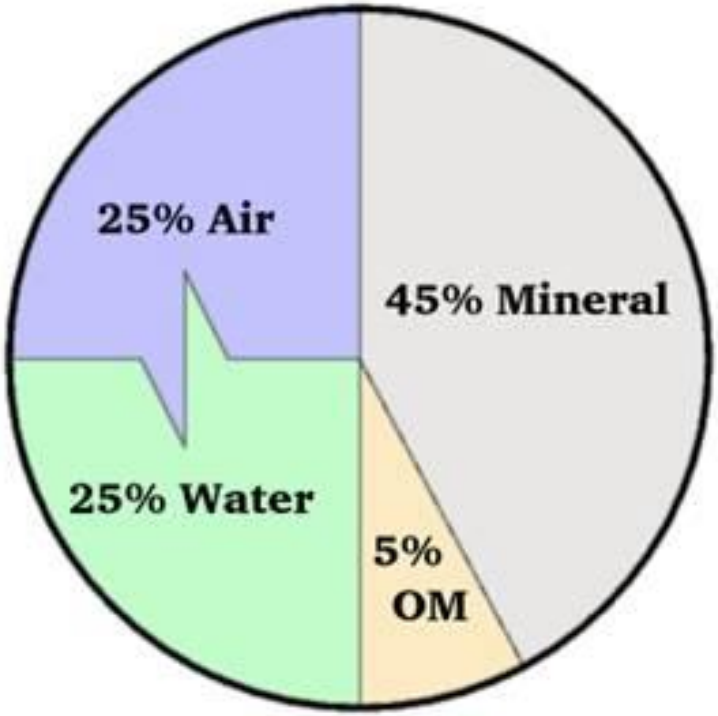




Engineering Medium

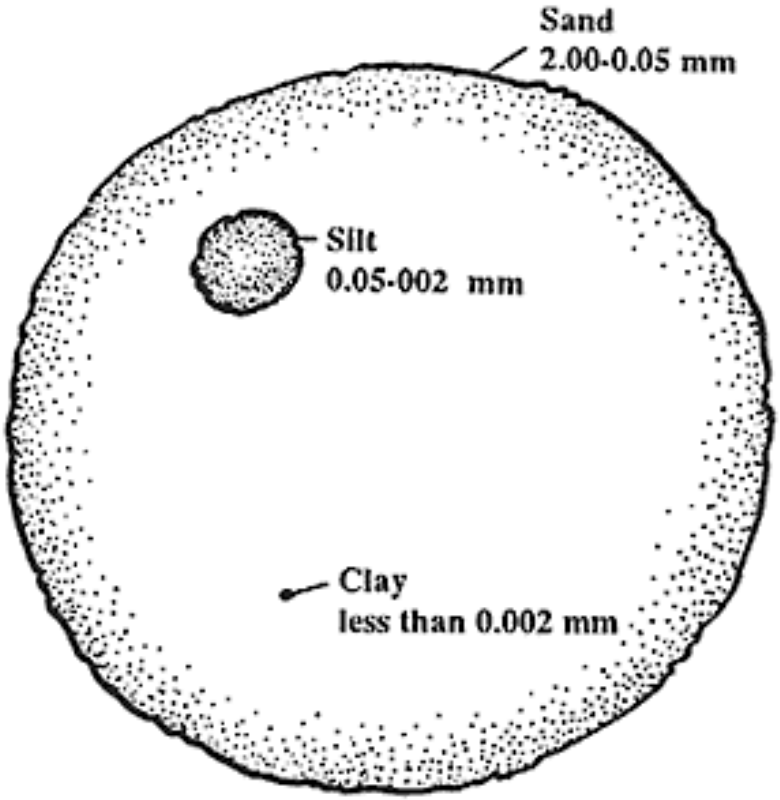
- Animal health begins with good nutrition
- Grasses and other plants are the source of nutrients
- Soils supply nutrients and store water for plant growth

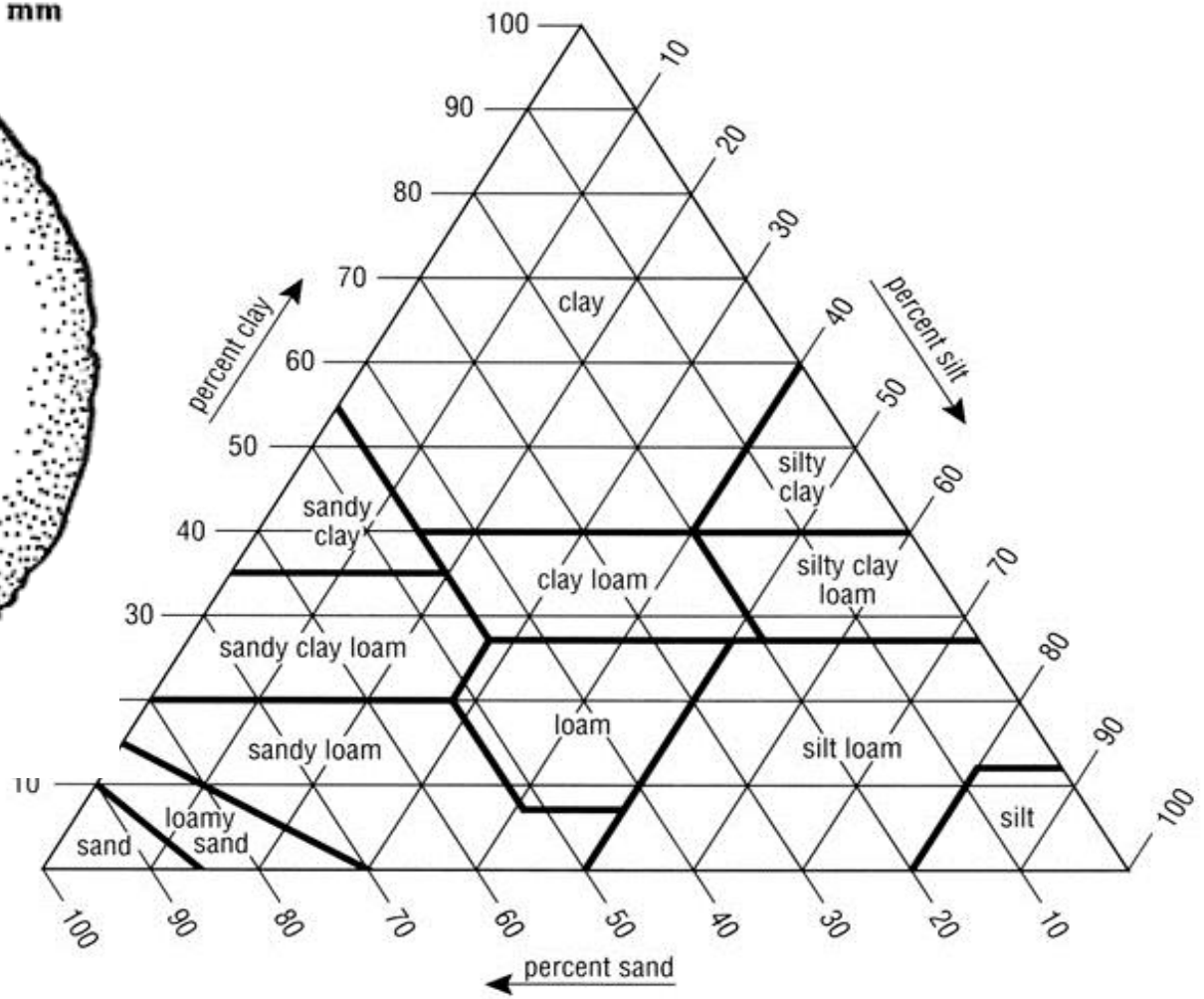
Soil Composition

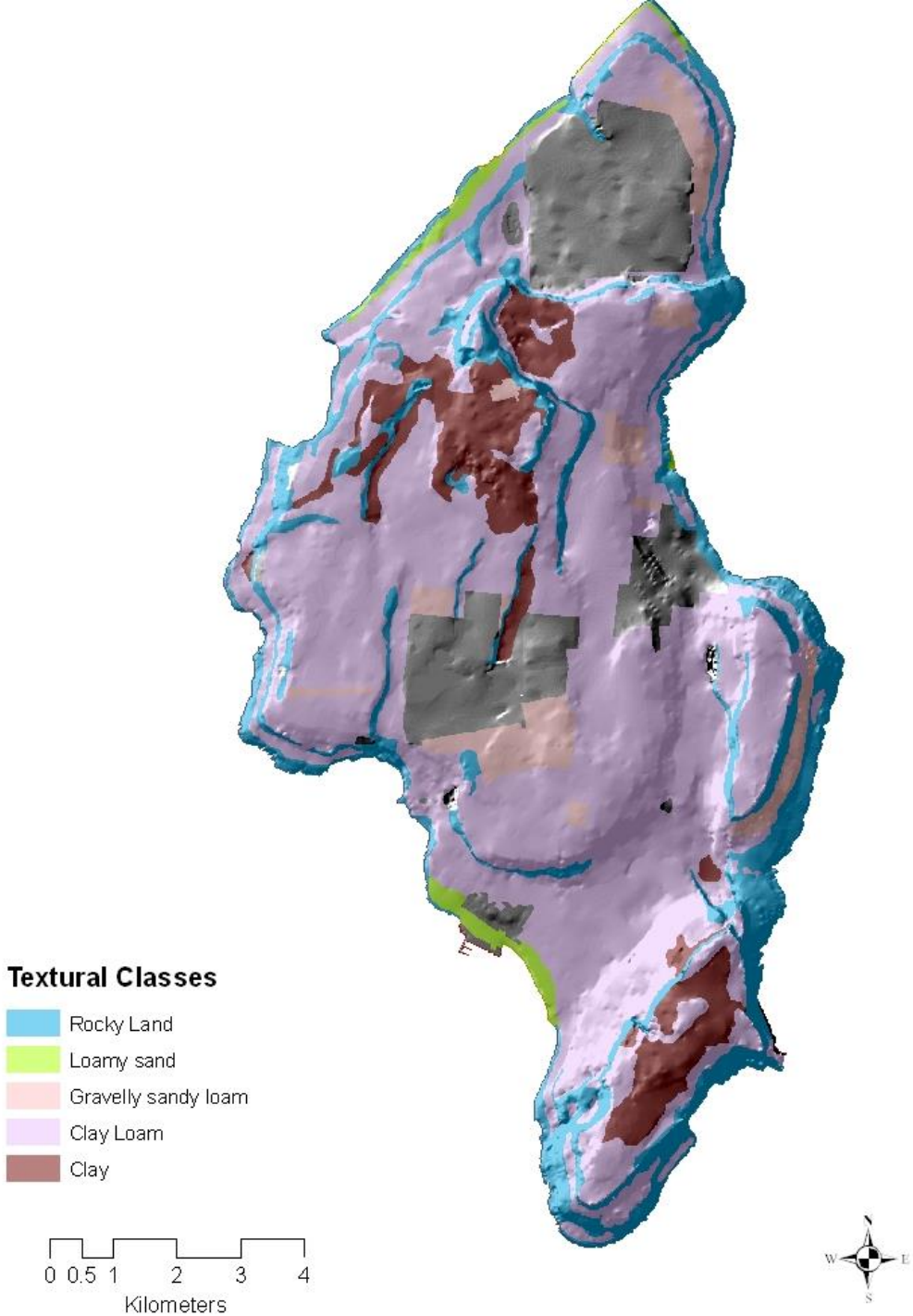


Photos: B. Gavenda

Soil Texture

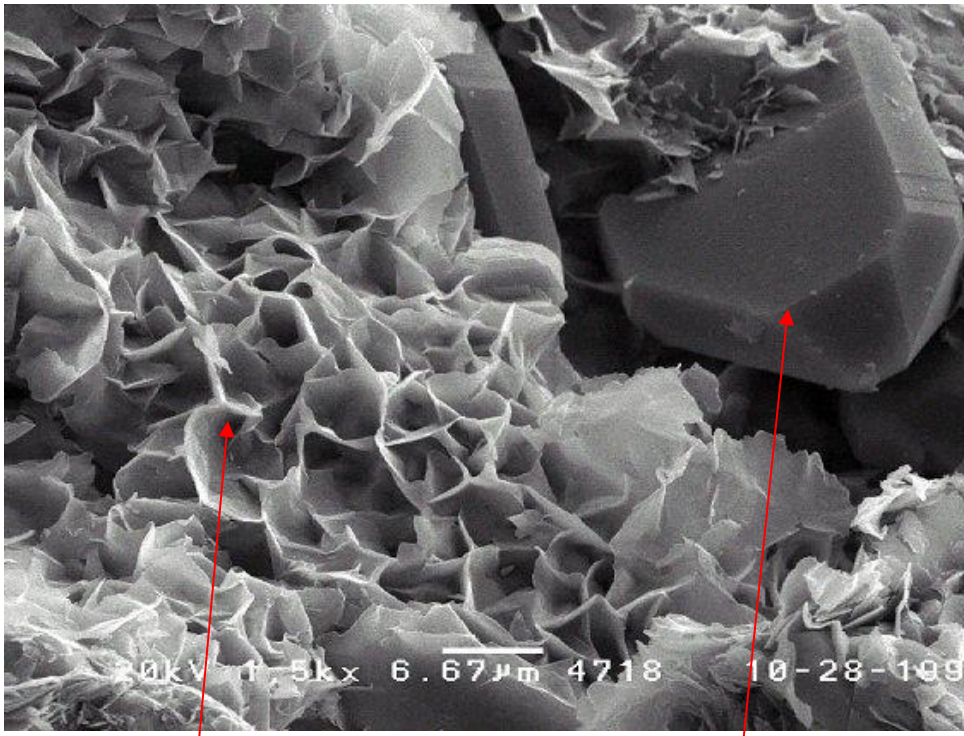




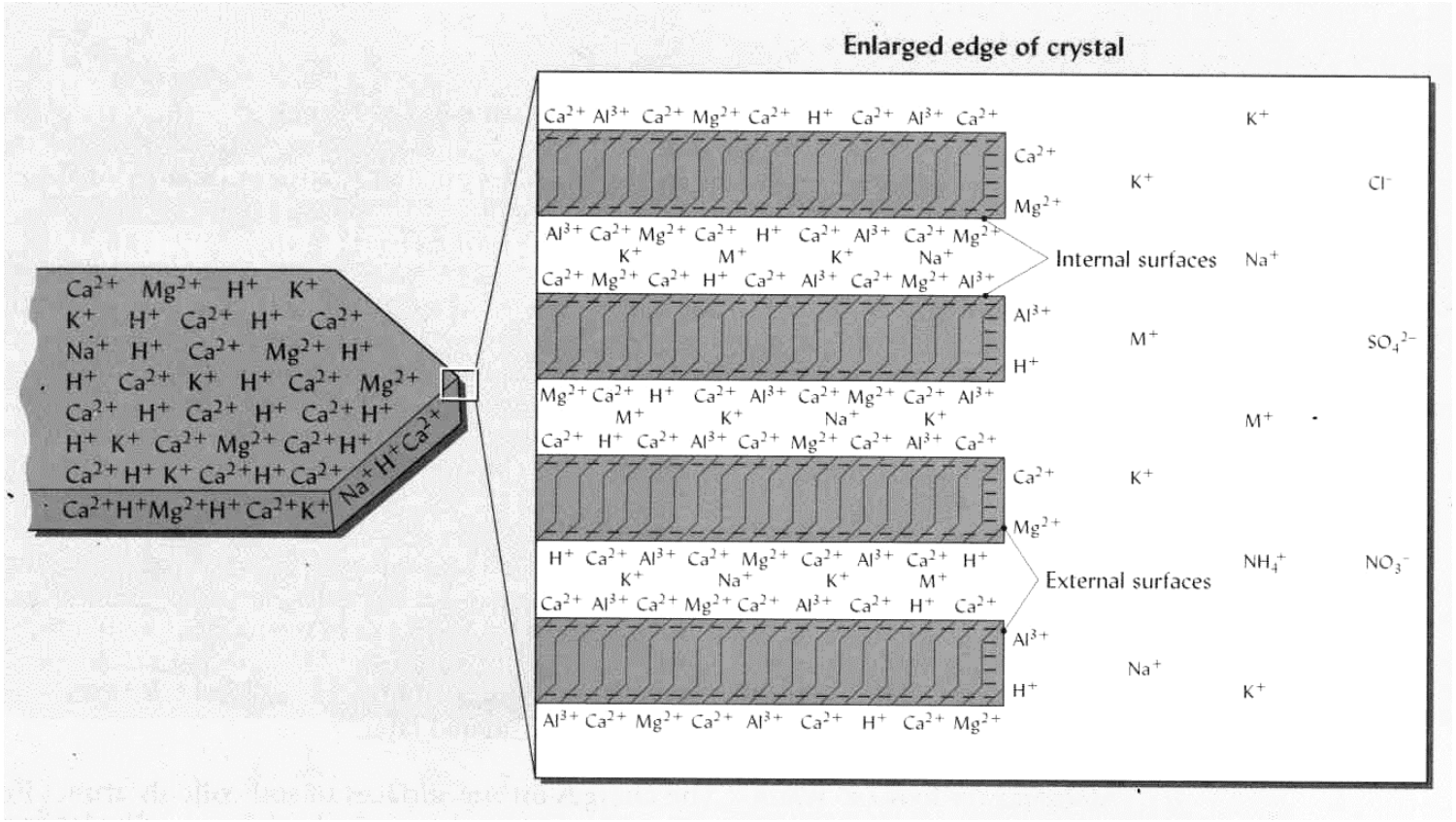

Textural Classes
Rocky Land
Loamy sand
Gravelly sandy loam
Clay Loam
Clay
0 0.5 1 2 3 4
Kilometers
N
W
E
S

Properties and Importance of Clay

- Properties
  - High surface area
    - 1 gram = 10 to 800 m^2
  - Charged surfaces
    - Usually negatively charged, but highly weathered oxide clays have + charge
- Importance
  - High water holding capacity
  - High nutrient retention capacity (cation exchange capacity, CEC)



Cation Exchange Capacity (CEC)

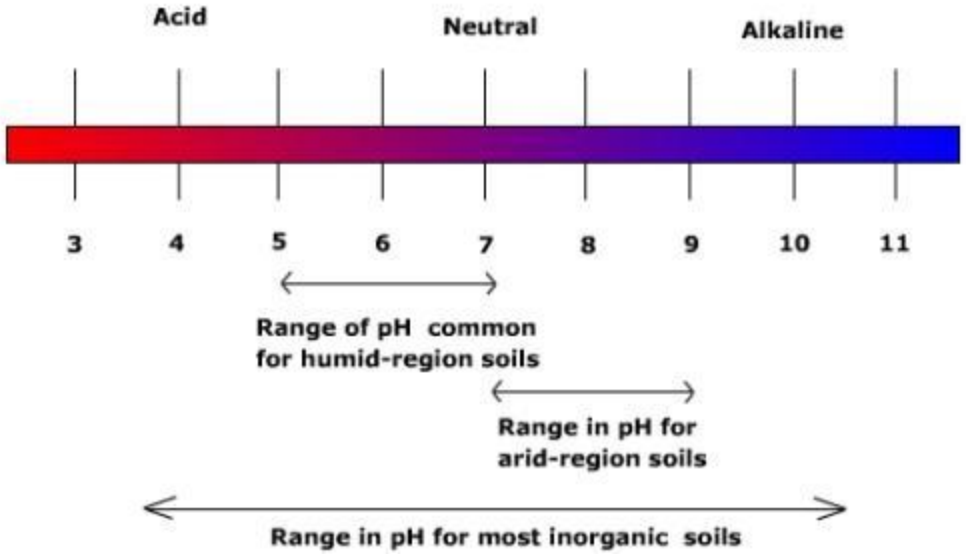


Negatively charged sites that adsorb cations:

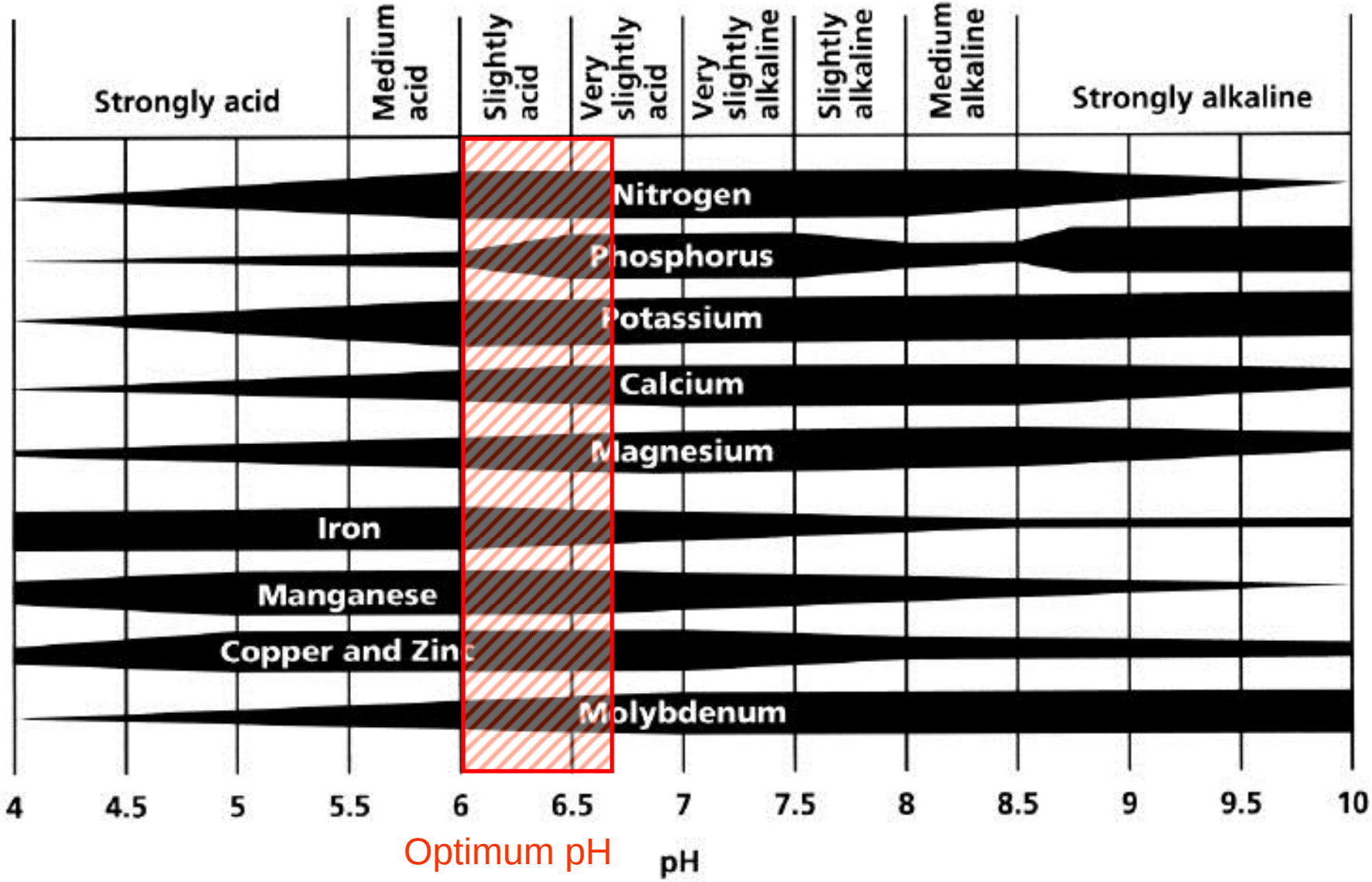
Ca^{2+}, Mg^{2+}, K^{+}, NH^{4+}

The pH Scale


Hydrochloric acid
Lemon
Apple
Banana
Water
Baking soda
Ammonia
Drain cleaner
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Most acidic
Most basic
Vinegar
Tomato
Milk
Blood
Soap

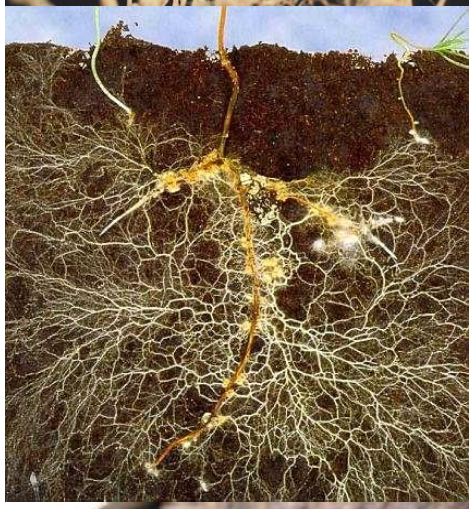

Acid
Neutral
Alkaline
3
4
5
6
7
8
9
10
11
Range of pH common for humid-region soils
Range in pH for arid-region soils
Range in pH for most inorganic soils

Soil Acidity and Nutrient Availability

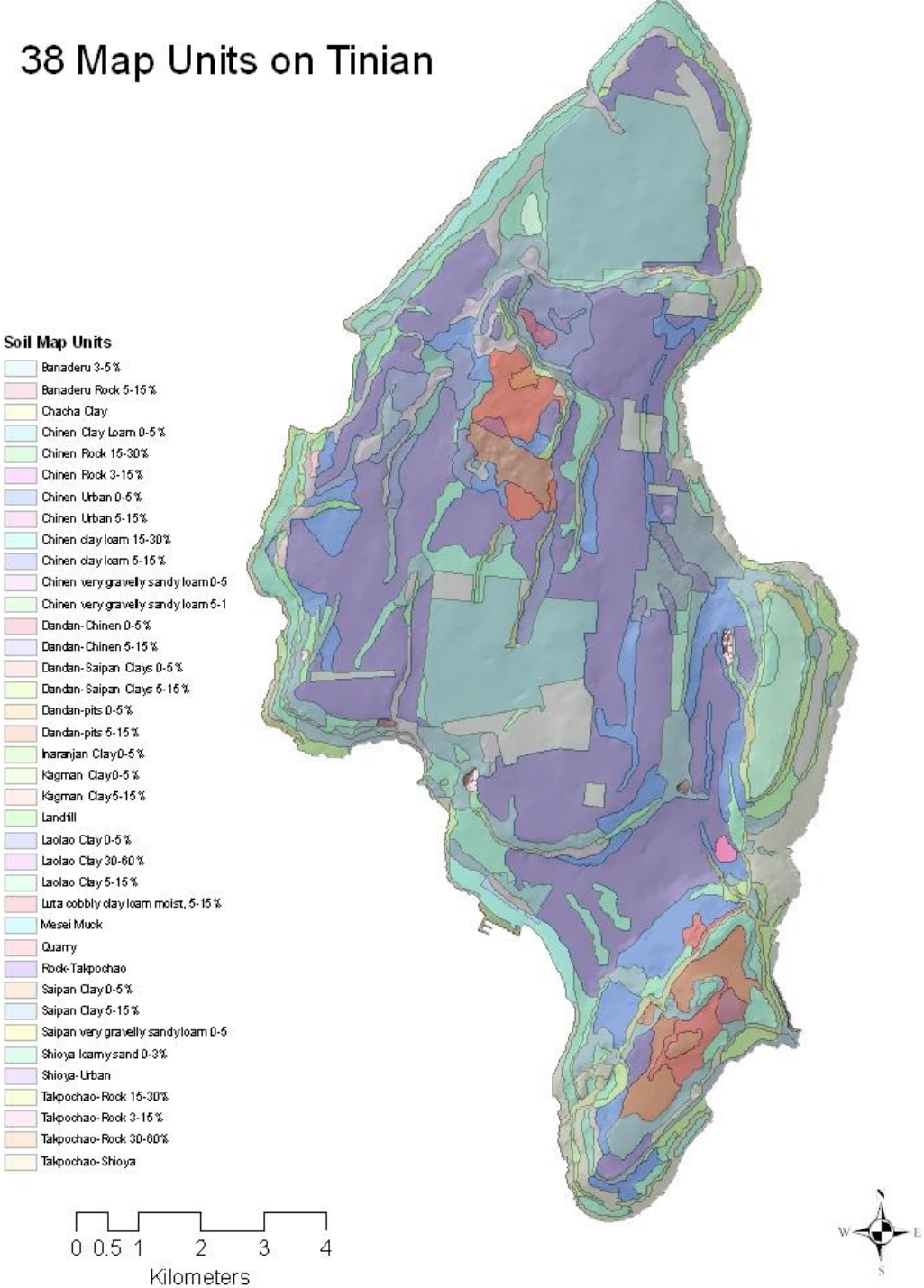


Role of Organic Matter in Soil

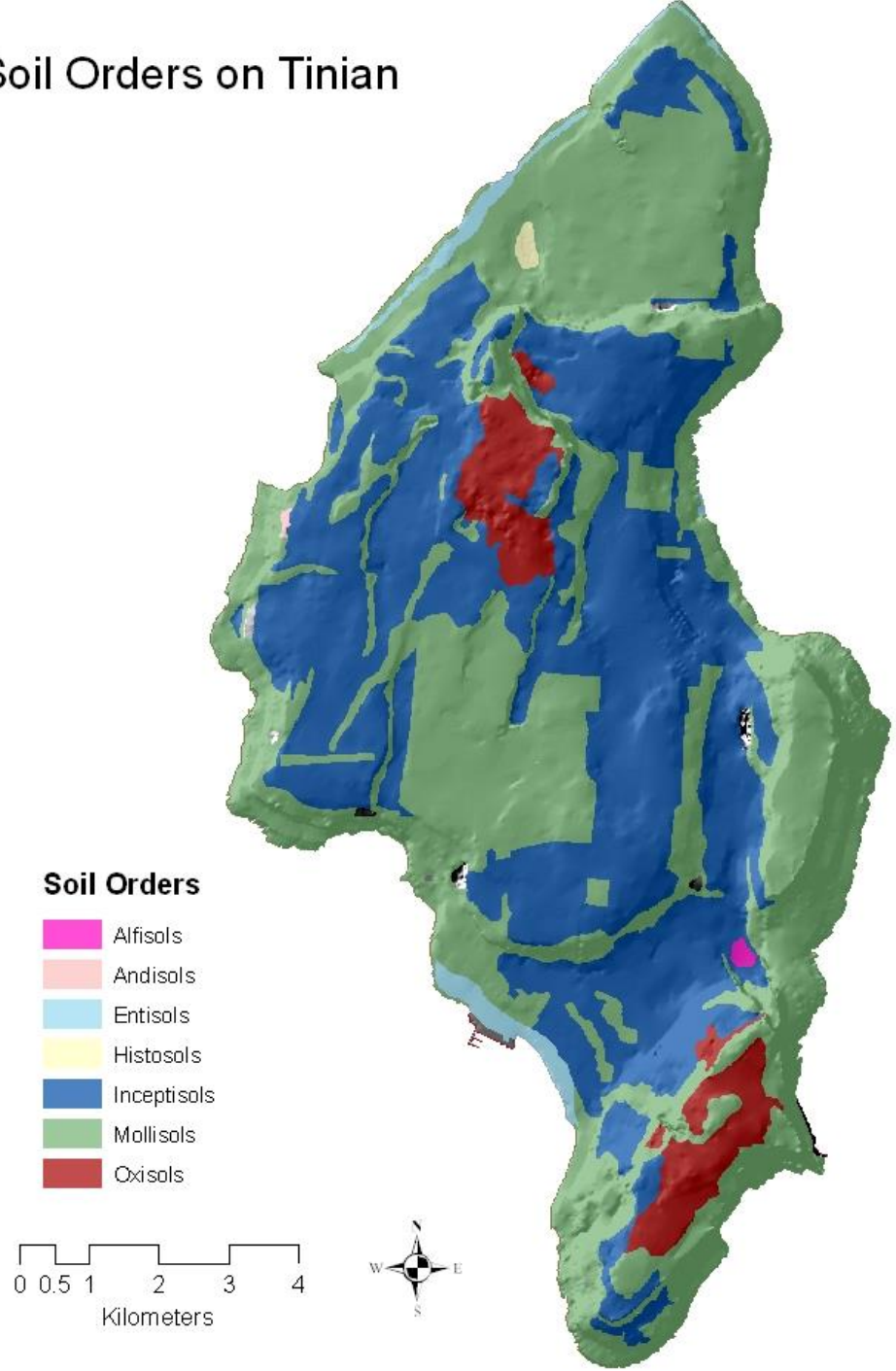
- **Physical**
  - Improves soil structure
  - Increases water retention
- **Chemical**
  - Increases nutrient availability (N & P cycling, solubility)
  - Increases nutrient retention (CEC)
  - Detoxifies Al
- **Biological**
  - Increases microbial diversity
  - N fixation (rhizobia), P availability (myccorhiza)
  - Increases pathogen suppression



38 Map Units on Tinian

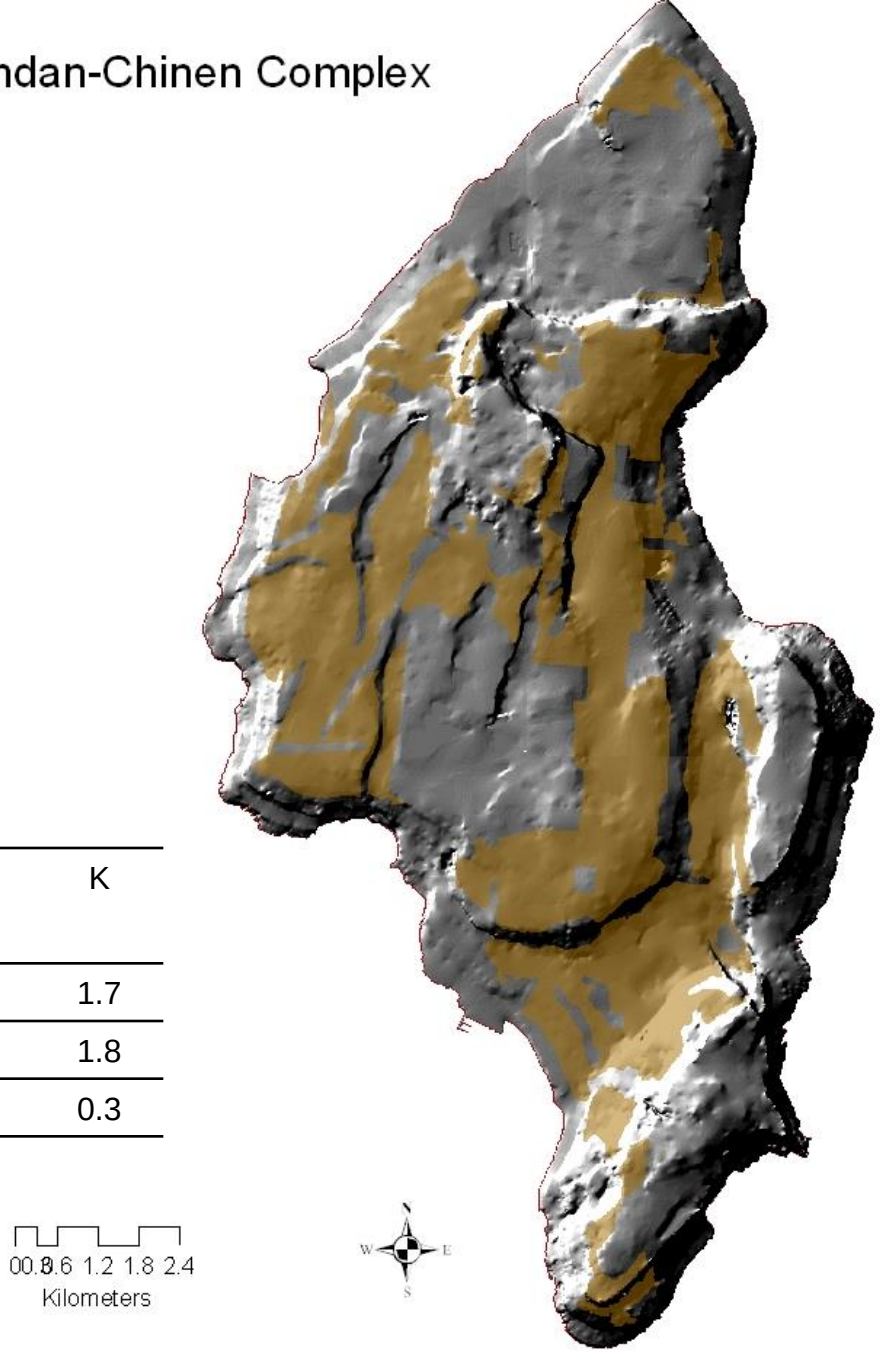


Soil Orders on Tinian

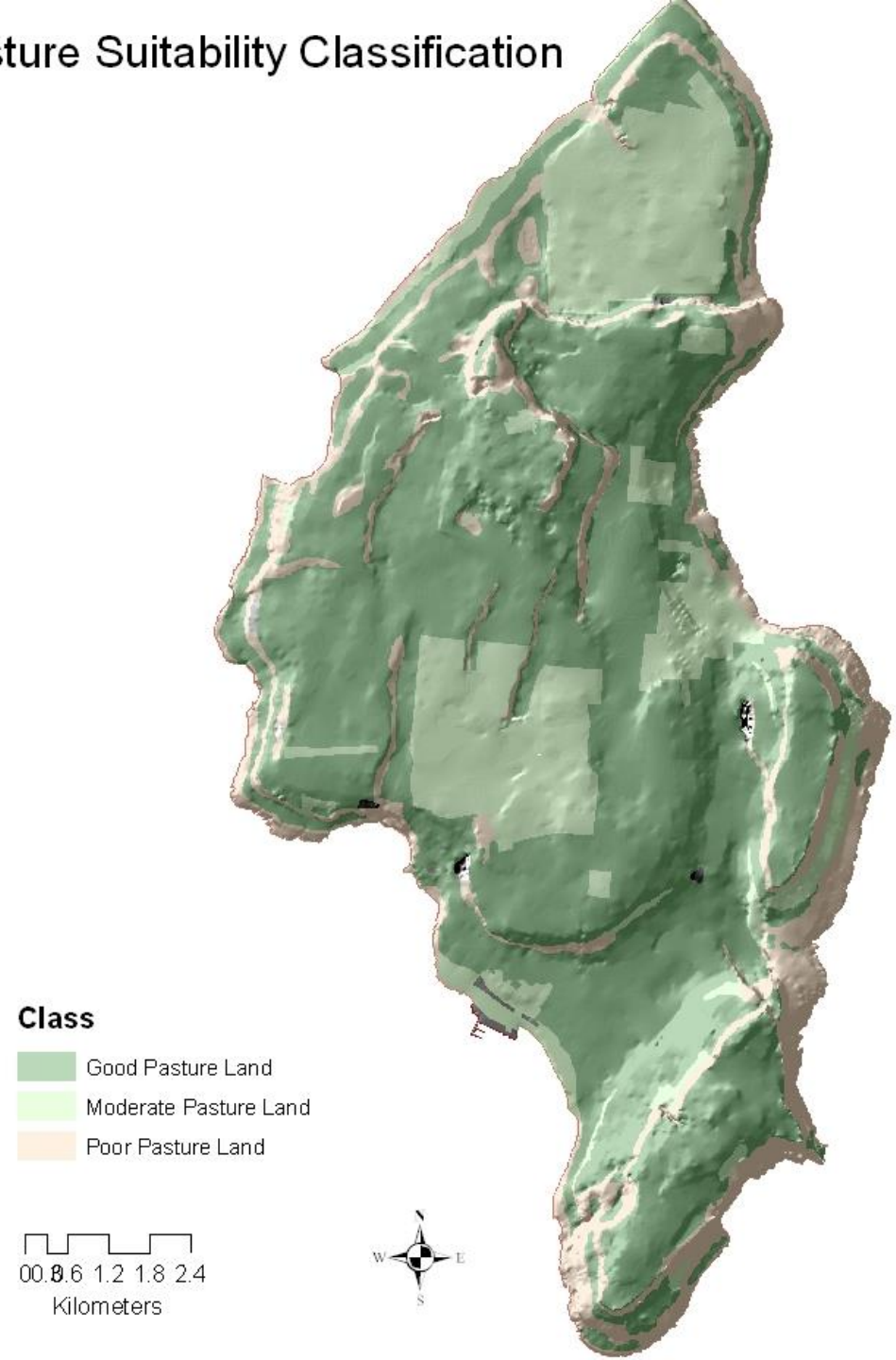


Dandan-Chinen Complex

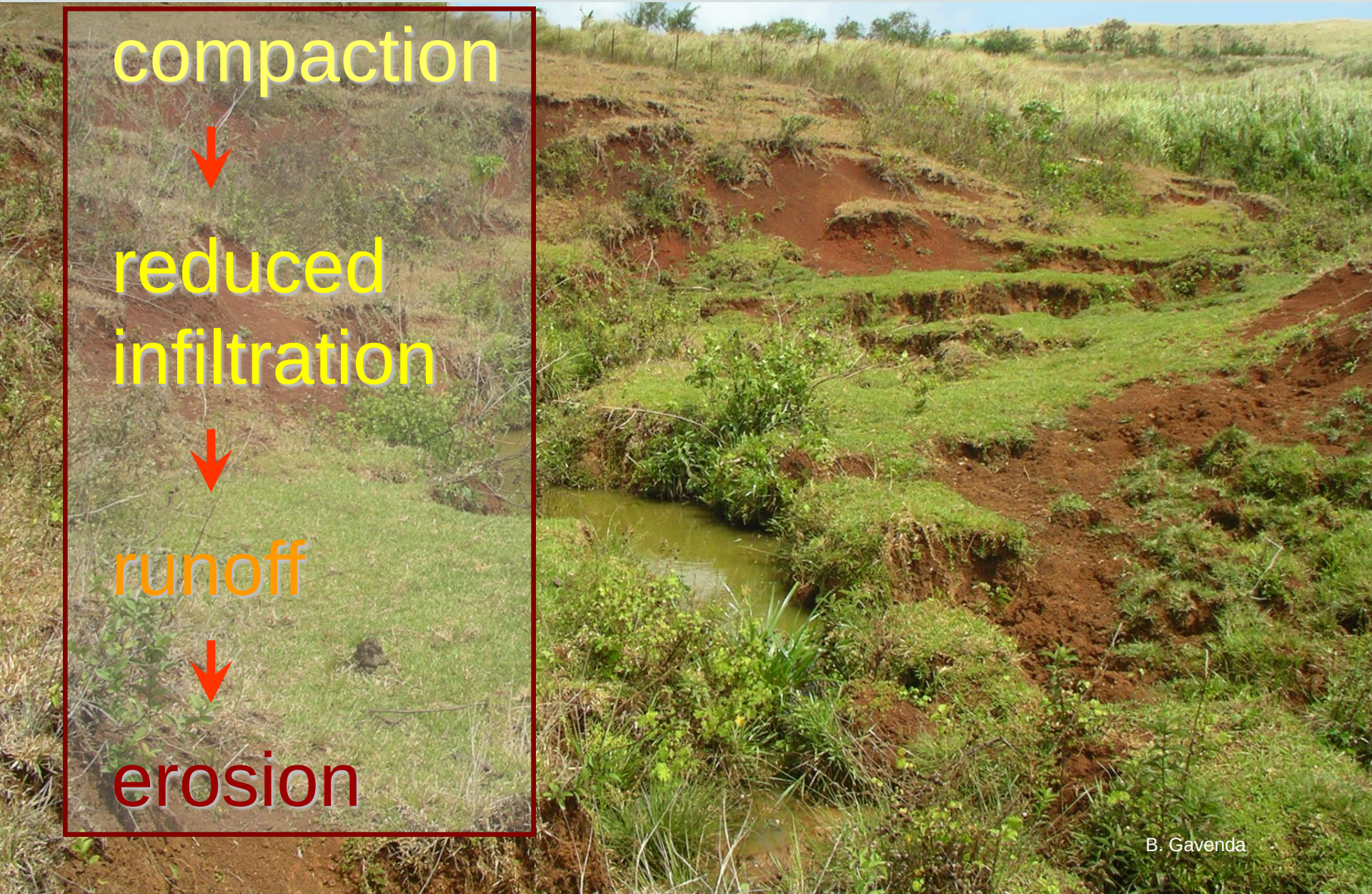
Horizon	%Clay	pH	% C	Ca	Mg	Na	K
cm					$cmol_c\ kg^{-1}$		
0-11	82.0		4.69	48.3	14.5	-	1.7
11-22	53.2		2.87	28.7	5.0	0.2	1.8
22-45	77.2		1.17	22.3	12.2	0.2	0.3



Pasture Suitability Classification



Grazing Management and Soil Quality



Grazing Management and Soil Quality


Soils are non-renewable!
B. Gavenda