

Soil Organic Matter Its Characteristics and Roles in Agricultural Environments

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Wise-being in the forest told



Homo ab Humo

- Human was born from a rich soil containing large amount of
- **Human – Humus – Humidity**
There is a profound connection between human, humus, and humidity.
- Sleeping mind of human “Terra as the mother”

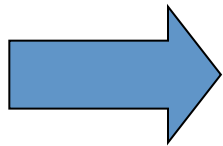
Do you feel soil dirty?

Take a clod of soil
into your hand,
watch and smell it.



We will be relieved by such soils:

- Black soil
- Soft soil
- Good smelling soil
- Soil in which small worms are living

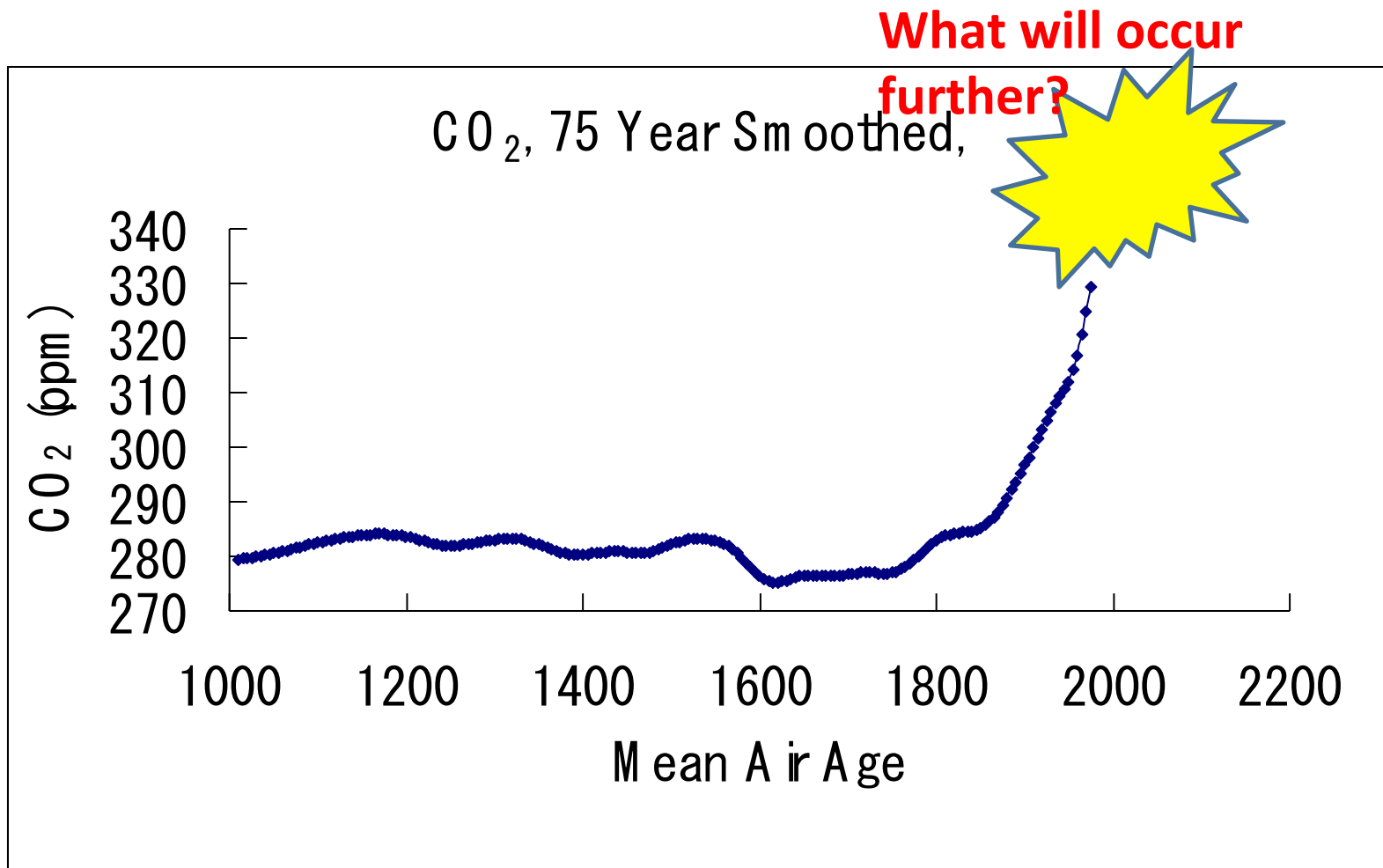


Such soils contain a suitable amount of organic matter.

Soil breeds life.

Evidence for this fact is

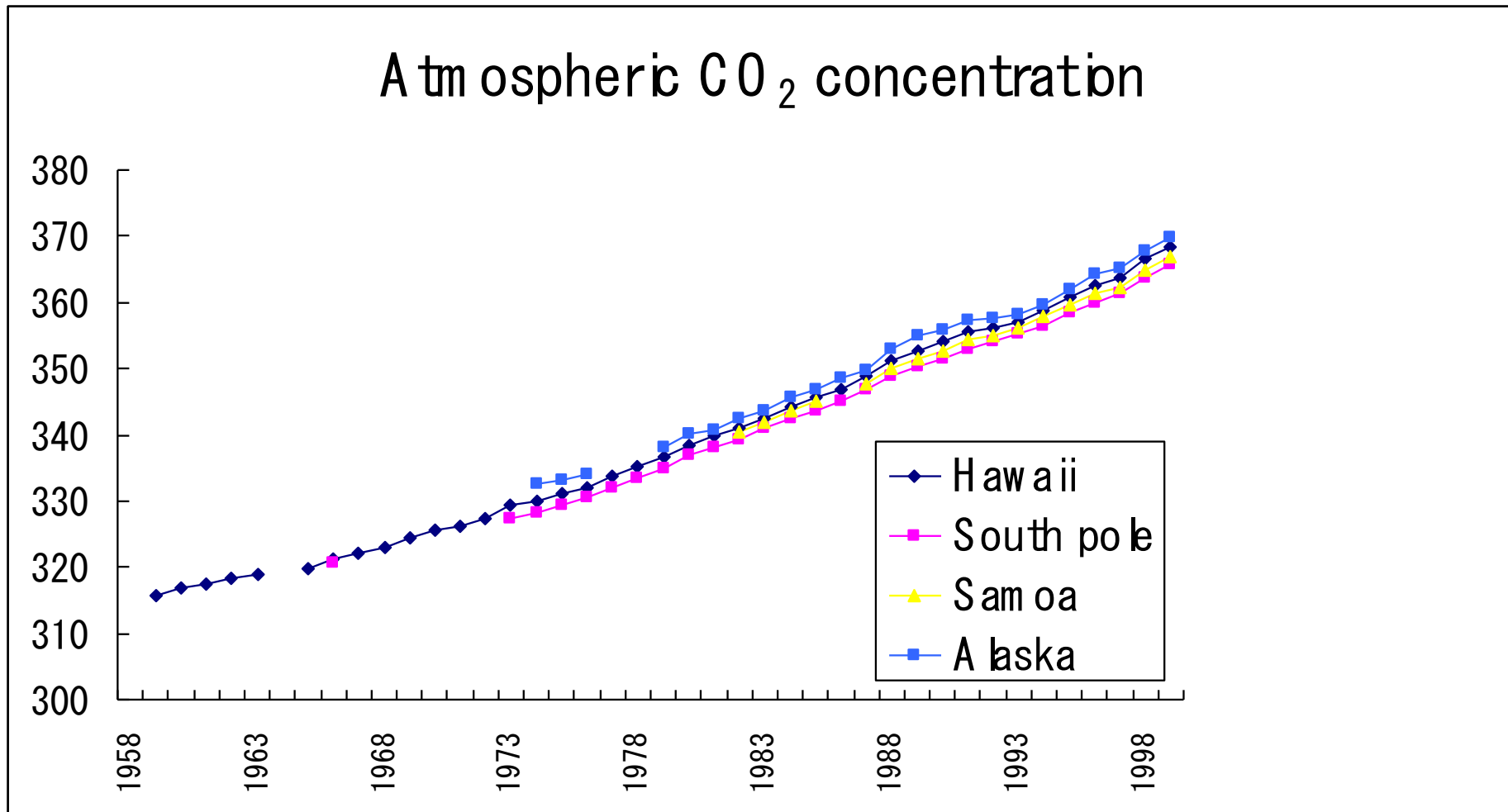
Soil Organic Matter.



Change in ambient CO₂

(Ice-core data of antarctics)

Increase in atmospheric CO₂ concentration

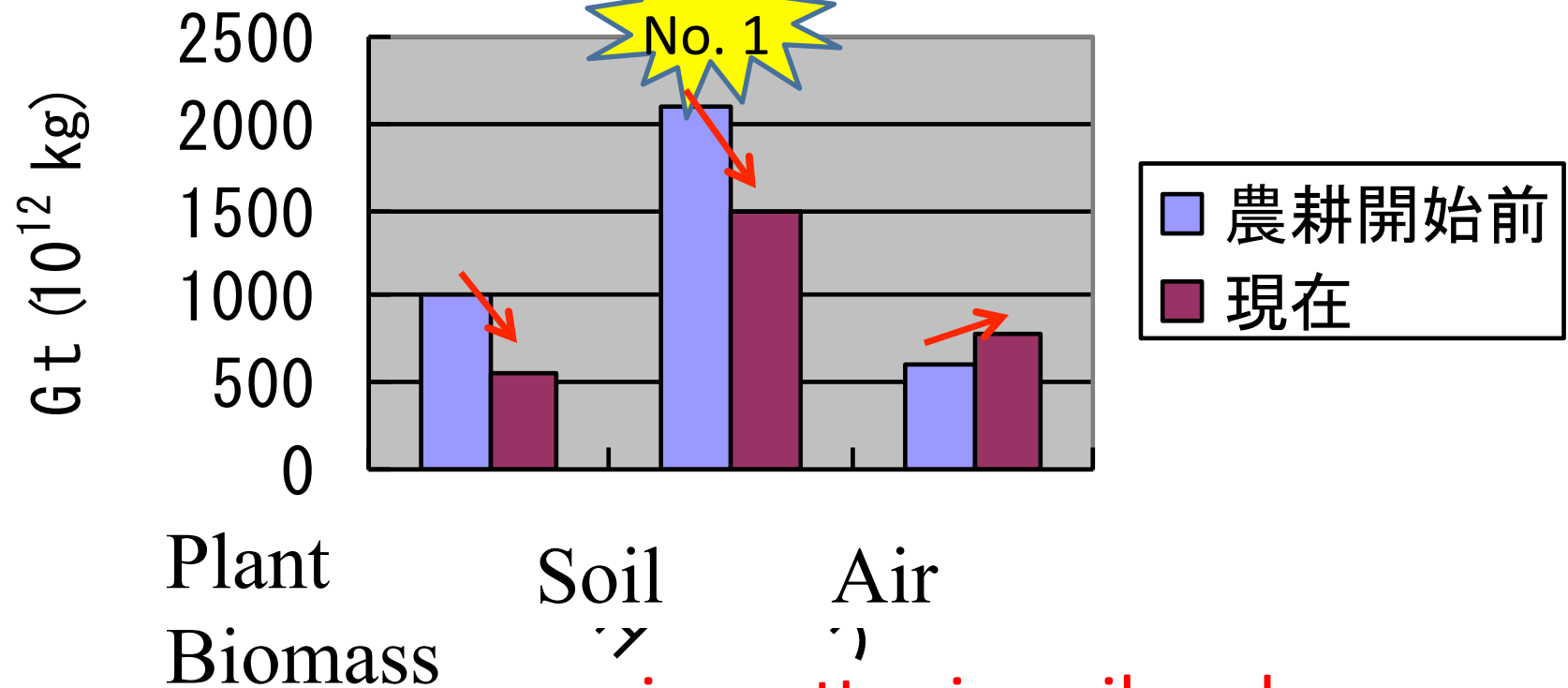


Stocks of carbon on the surface of earth

Stock pools		Stored amount
		10^{12} kg
Earth		
Plant biomass		550
Soil humus		1500
Atmosphere	1850 (CO ₂ 260 ppm)	560
	1890 (CO ₂ 290 ppm)	630
	2000 (CO ₂ 390 ppm)	820
Ocean		38000
Carbonate salts		20×10^6
Dissolved organic matter		600
Solid suspension and sediments		3000
Earth crust (fossil fuel)		4000
Total amount		44800

Hunt(1972), Paul and Clark(1989), Eswaran et al.(1993)
 CO₂ concentration was calculated from ice-core data
 in Law Dome Antarctica.

Distribution of carbon on the earth



植物バイオマス

Organic matter in soil and vegetation decreased remarkably due to civilization.

Humic substance is

- The most abundant organic matter on the earth surface. As carbon amount
1500 Gt (10^9 t, 10^{12} kg)
 - 3 times more abundant than plant biomass
 - 2 times more abundant than CO₂
- 2100 Gt of humus carbon in pre-historic age.

Biomass production and respiration/ combustion on the earth (10^9 t/year)

	Biomass production	CO ₂ formation
Plant	500	34.5
Animal	0.5	4.1
Human	0.1	0.7
Microbes	1.0	112
Wild fire		6.9
Volcano		0.15
Factory		15
Total	502	173.5

Emission of CO₂ due to human activity

Factors	Increase rare of CO ₂ carbon
	Gt (10 ⁹ t)/year
Fossil fuel combustion	7
Land use change	2.2

Land-use change

Forest clearing

Slash and burn

Grassland to upland field



Large amount of gas is emitted from soil surface



World energy consumption (2003)

Source	Consumption (petroleum equivalent 10^8 tons)	
Petroleum	36.4	85.5
Natural gas	23.3	
Coal	25.8	
Atomic	6.0	12.0
Hydraulic	6.0	

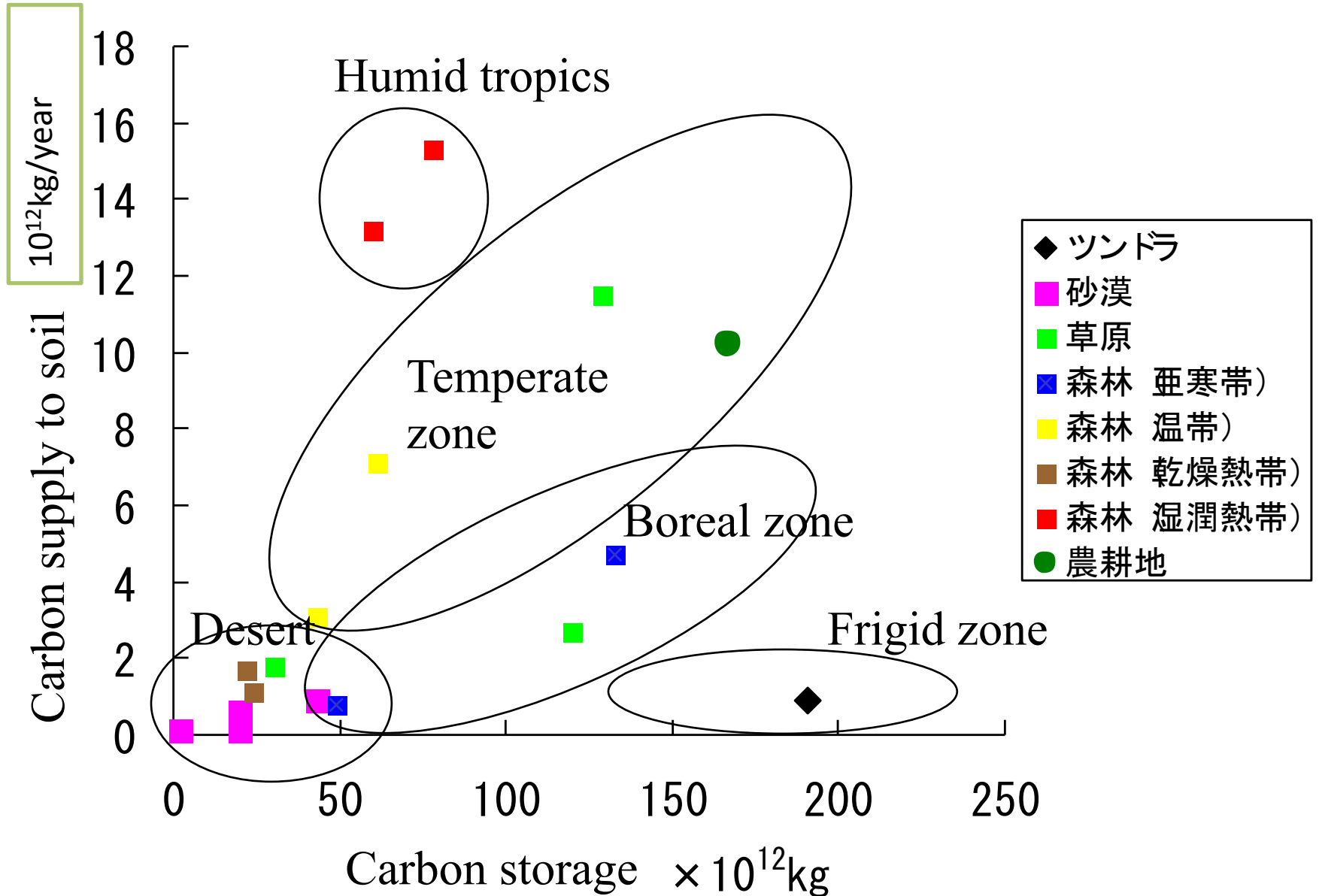
CO₂ emission

heat emission

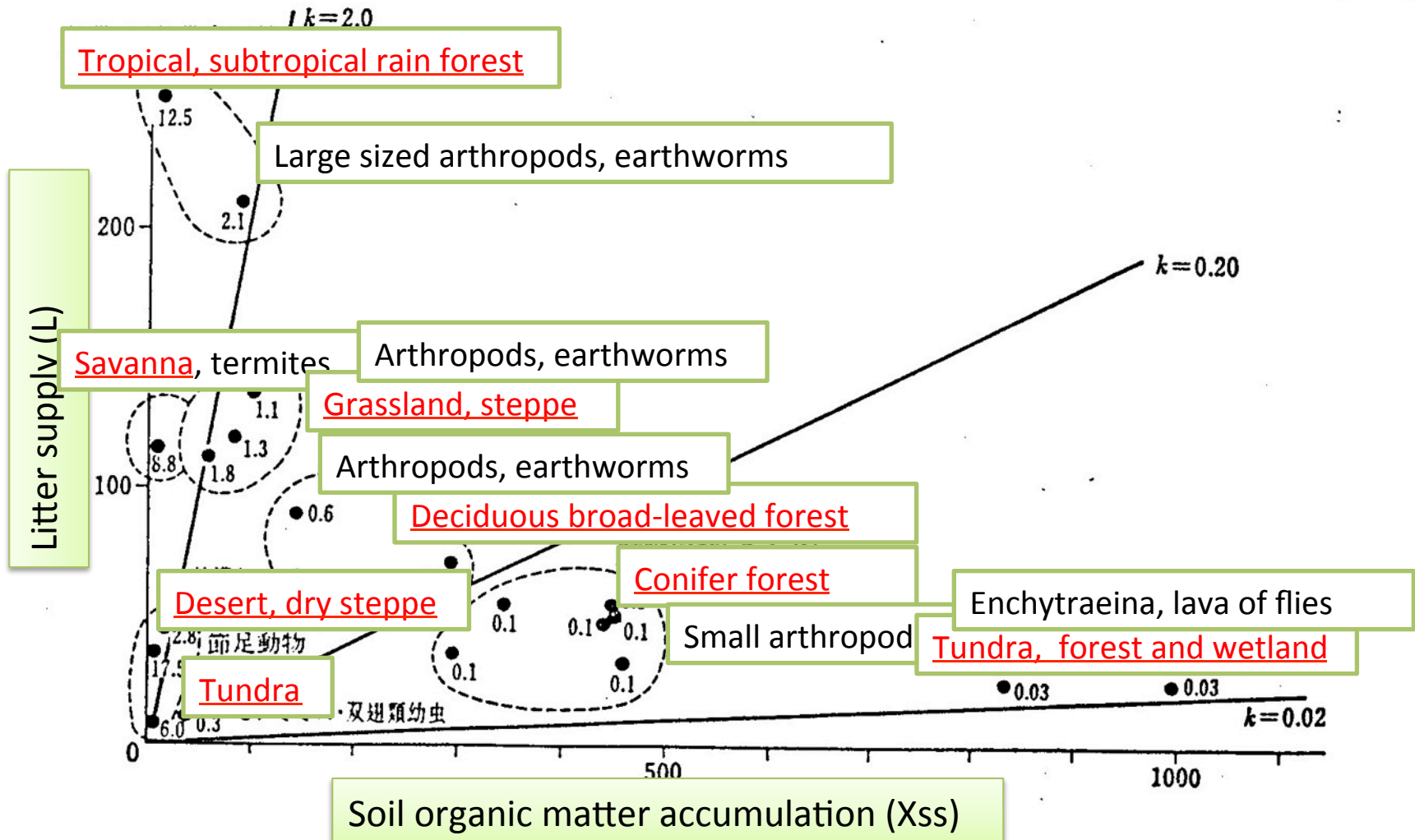
Energy consumption per capita

- World 1.7 ton annually
(petroleum equivalent)
- Japan 4.1 ton annually
- USA 8.0 ton annually
- Human activity causes the increase in atmospheric CO₂ concentration.
- Plant and soil absorb CO₂.

Supply and storage of carbon in soil



Litter supply and SOM accumulation



主要な生態系型の落葉供給量, (L), 土壌有機物の蓄積 (X_{ss}), 分解率 $k=L/X_{ss}$, および
 主要な分解動物群 図中の数字はそれぞれの地点での k の値を示す。

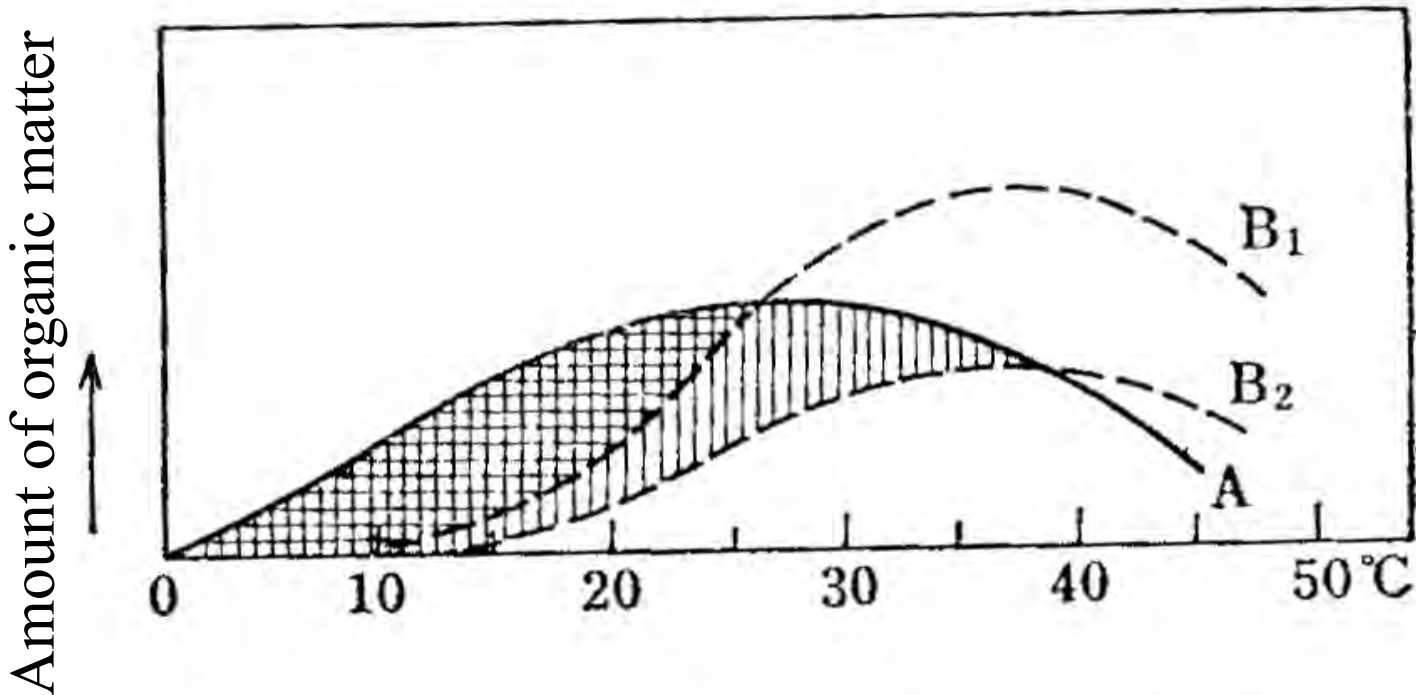
Primary forest in Baybay, Leyte



Primary forest soil profile in Baybay, Leyte



Factors affecting SOM accumulation: temperature and moisture content of soil



 Aerobic upland soil

 Anaerobic flooded soil

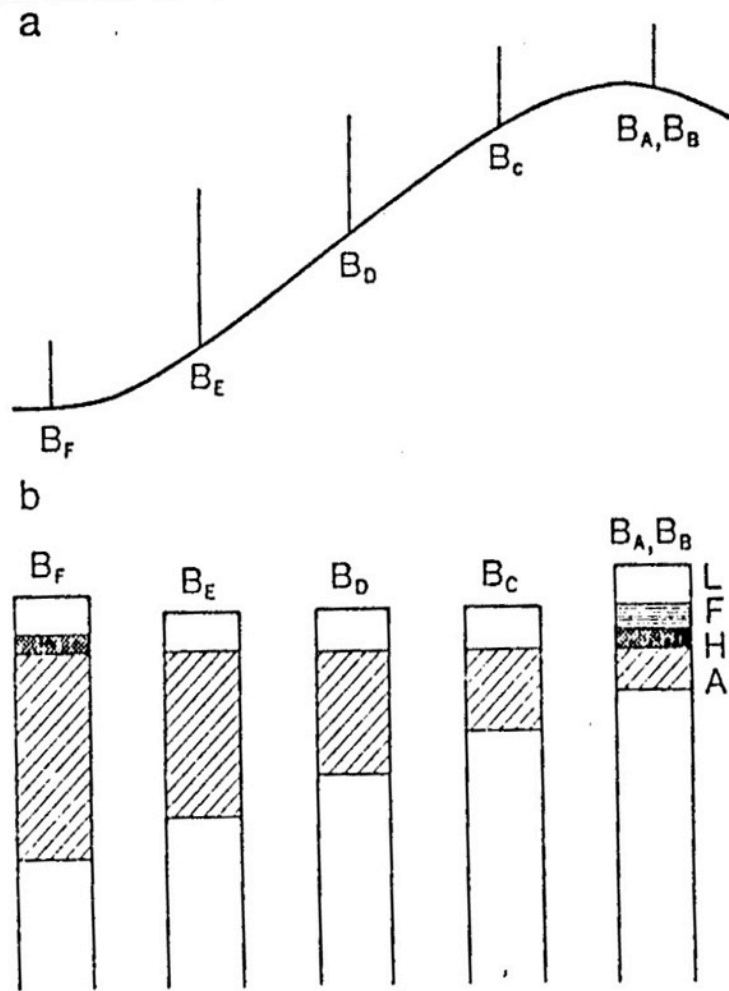
A Organic matter production by plant

B₁ Organic matter decomposition in aerobic soil

B₂ Organic matter decomposition in anaerobic soil

Amounts and Turnover Rates of C and N in the Microbial Biomass for Cultivated Soils for Three Locations

Soil and Location	Microbial C kg/ha	Microbial N kg/ha	C Inputs Mg/ha/yr	Nitrogen Flux through Microbial Biomass kg/ha/yr	Microbial Turnover Time yr
Temperate					
England	570	95	1.2	34	2.5
Canada	1600	300	1.6	53	6.8
Tropical					
Brazil	460	84	13	350	0.24



Schematic representation of soil types (B_A — B_F) of Brown forest soil.
 a: topographic location; b: A_0 and A horizons. Vertical lines indicate growth of the tree.

Red pine forest

(Yaotsu, Gifu prefecture)

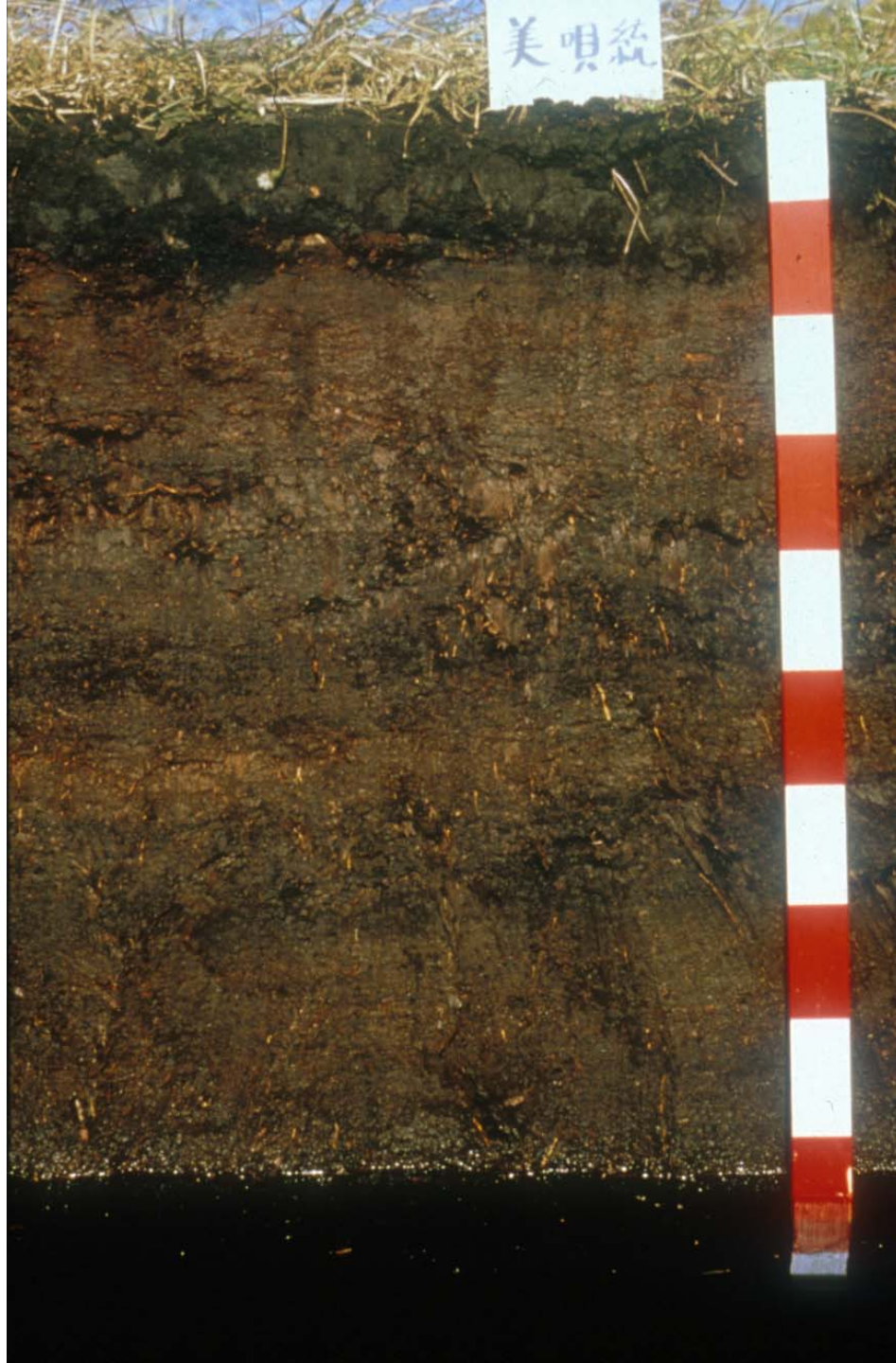


Brown forest soil B_B type (Yaotsu, Gifu)

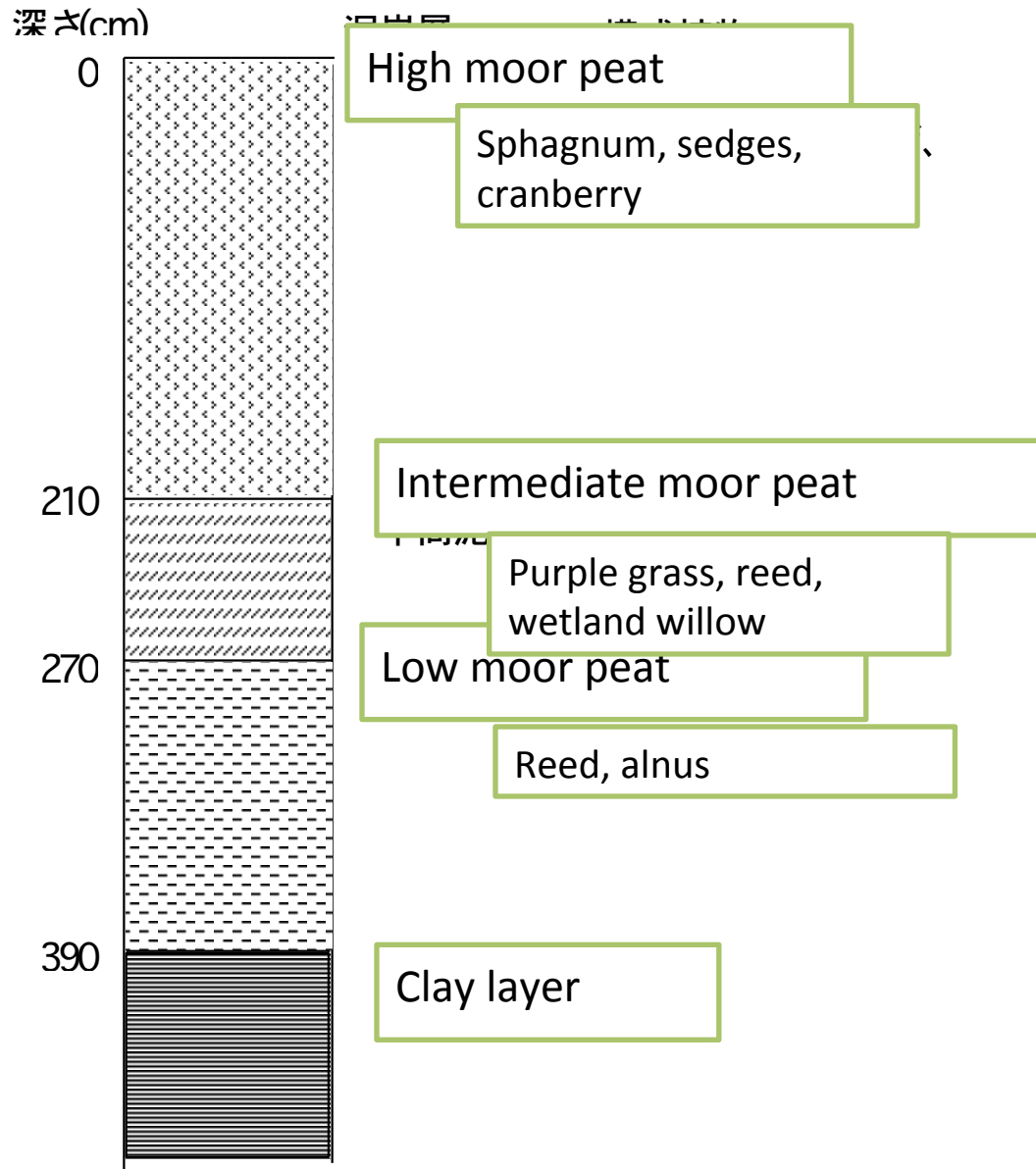


Litter layer of forest soil (O, A₀ layer)

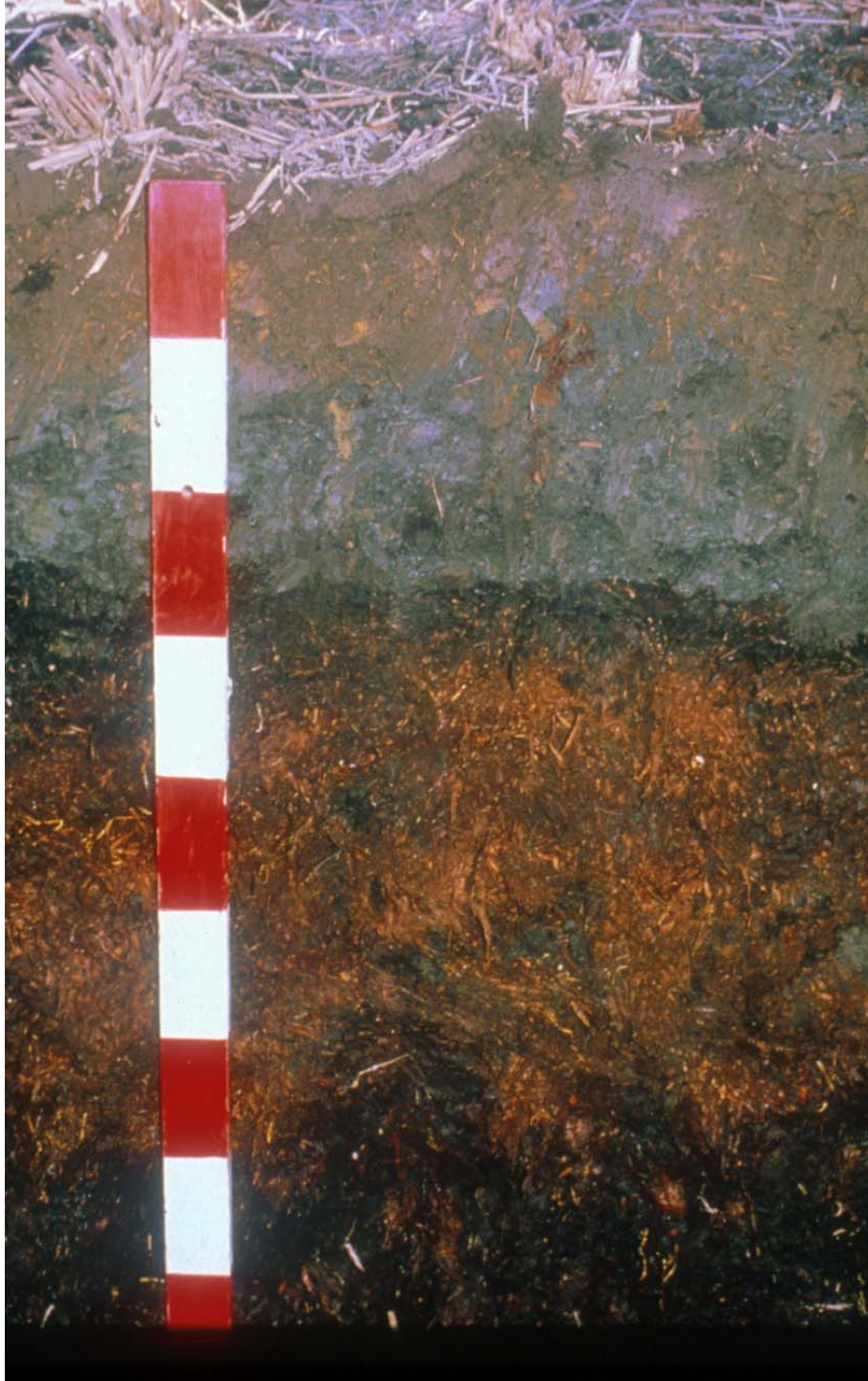




Peat soil in Bibai



High moor peat soil profile in Bibai



Peat soil with dressed soil (Nanporo town)

Asel forest near Hildesheim, Germany



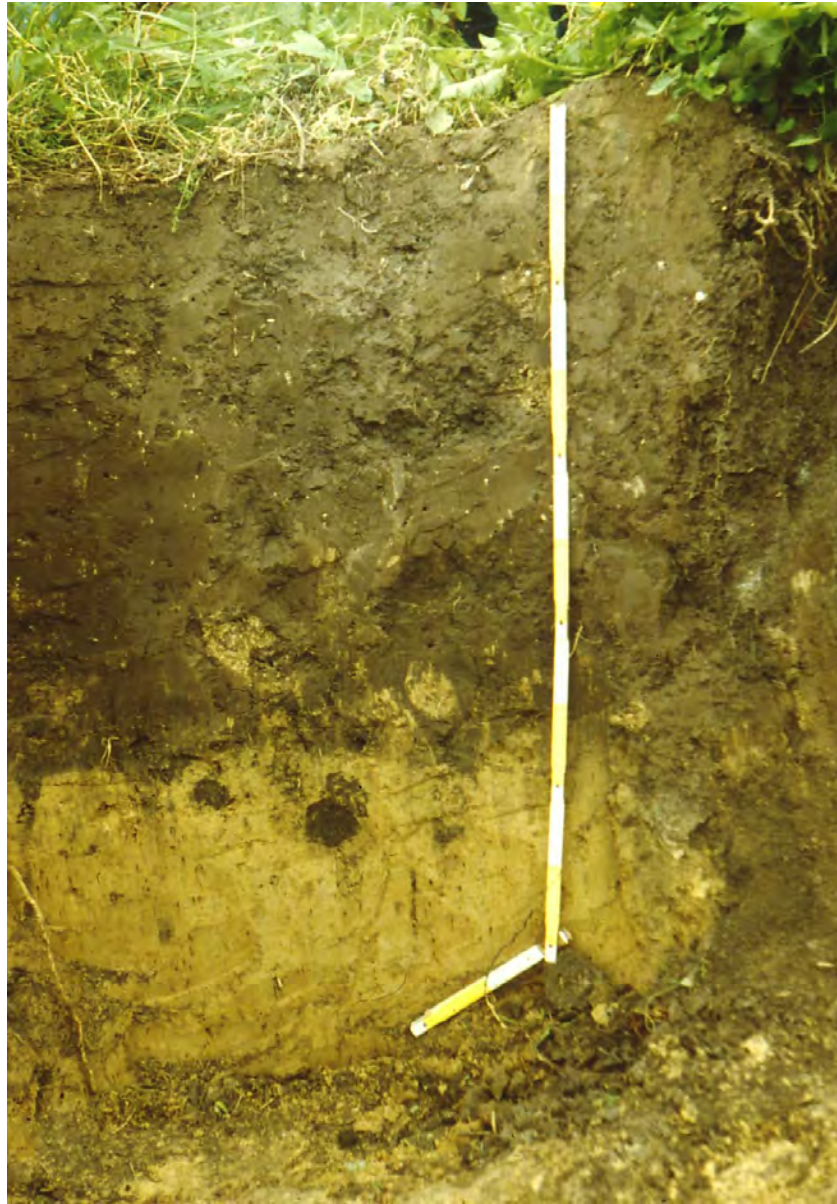
Black soil in Asel forest, Germany



Wheat field in Soellingen/Germany

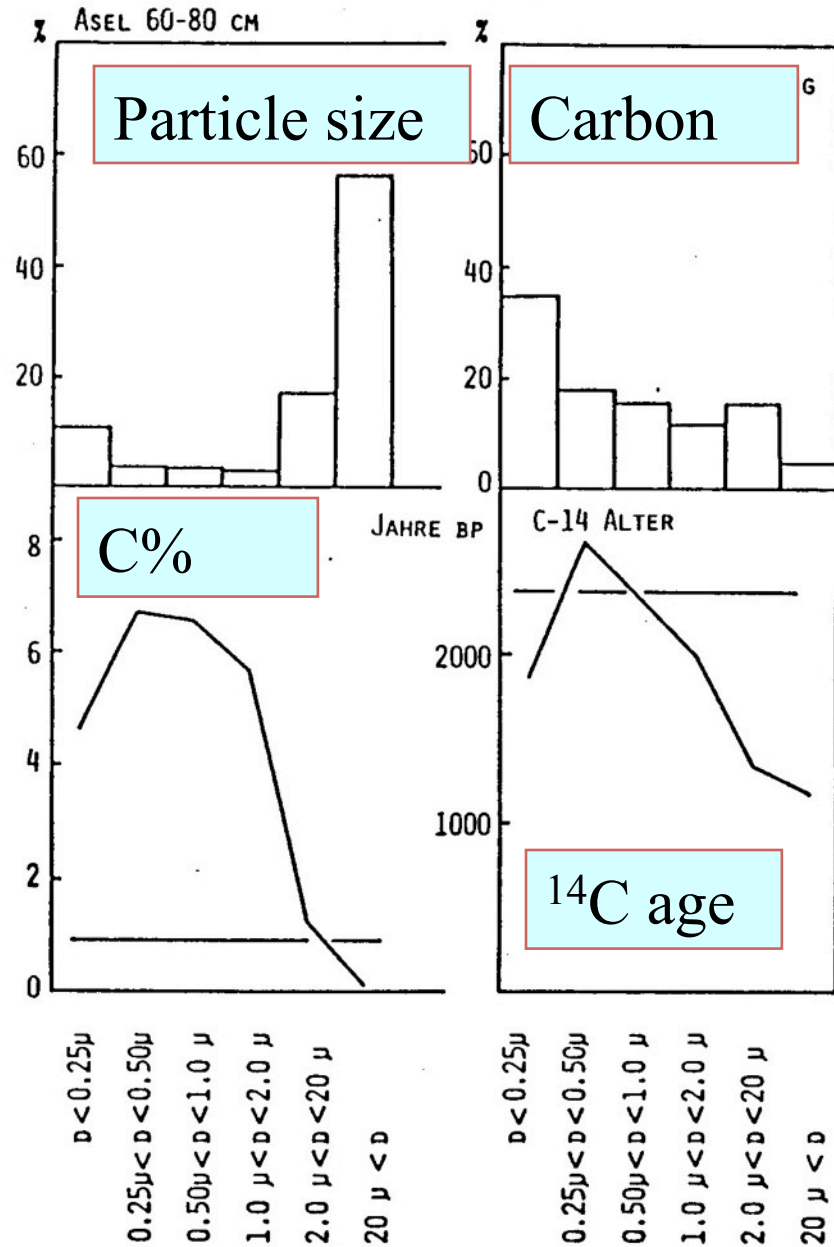


Black soil in Soellingen upland field



Soil organic matter stabilization on different size of soil particles

Organic matter bound to clay lasts long in soil



Stabilization and abundance of organic matter constituents in soil					
Constituents		Abbreviation	Mean Residence Time	S (kg)	A ₀ (kg)
Fresh organic matter (yearly input)					1000
Decomposable Plant Material		DPM	1	10	10
Refractory Plant Material		RPM	3.9	470	120
Biomass		BIO	25.9	280	10.8
Physically stabilized organic matter		POM	94.8	11.3×10 ³	119
Chemically stabilized organic matter		COM	2565	12.2×10 ³	4.76
Whole Soil Organic Matter		SOM	1334	24.3×10 ³	265
Jenkinson and Rayner, Soil Science 123, 6, 1977					
S (kg) : Expected accumulation of organic matter after 10000 years					
when 1000kg ha ⁻¹ of fresh organic matter is incorporated every year.					
A ₀ (kg) : Yearly gain of soil organic matter (kg ha ⁻¹) ,					
Calculated from S and meanage. A ₀ = S/Average Age					

Accumulation of organic matter in soil

$$S = (1/\log_e 2) A_0 H$$
$$= 1.44 A_0 H$$

S: Accumulated amount of organic matter after infinite years

A_0 : Added amount of organic matter in one year

H: Half life of organic matter

1.44H: Mean residence time