Midwest Soil Improvement Symposium: 2012

Research and Practical Insights into Using Gypsum

Gypsum's Effect on Soil and Water Quality

Dr. L. Darrell Norton (retired)

Soil Scientist, National Soil Erosion Research Lab

USDA-Agricultural Research Service

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Gypsum's Effect on Soil and Water Quality

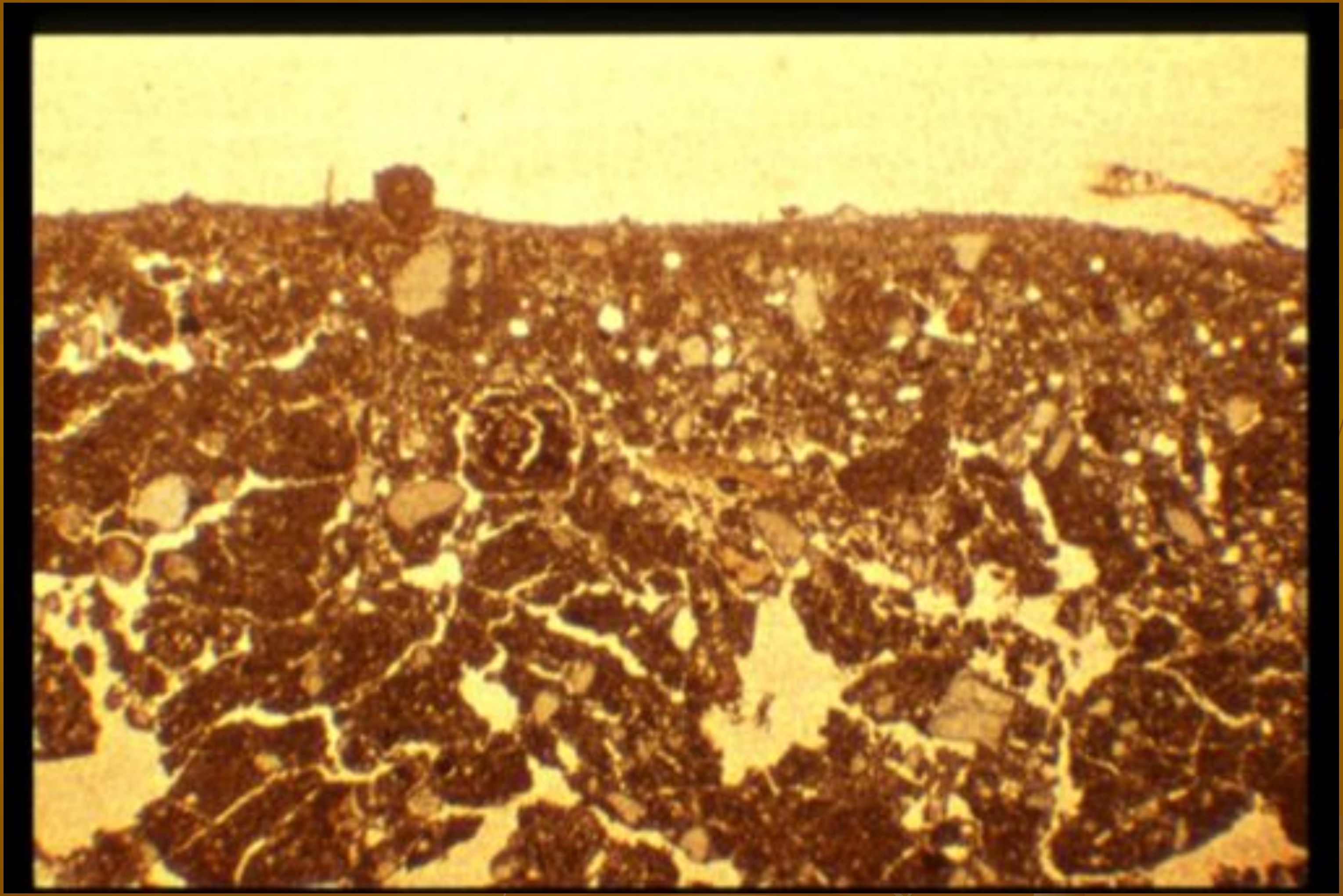
Dr. L Darrell Norton, (Retired) Research Soil Scientist USDA-ARS National Soil Erosion Research Laboratory, Purdue University, West Lafayette, IN

Midwest Soil Improvement Symposium: Research and Practical Insights into Using Gypsum, Aug. 21, 2012 Acadia, IN

Rainwater is Natural Distilled and Low in Electrolytes

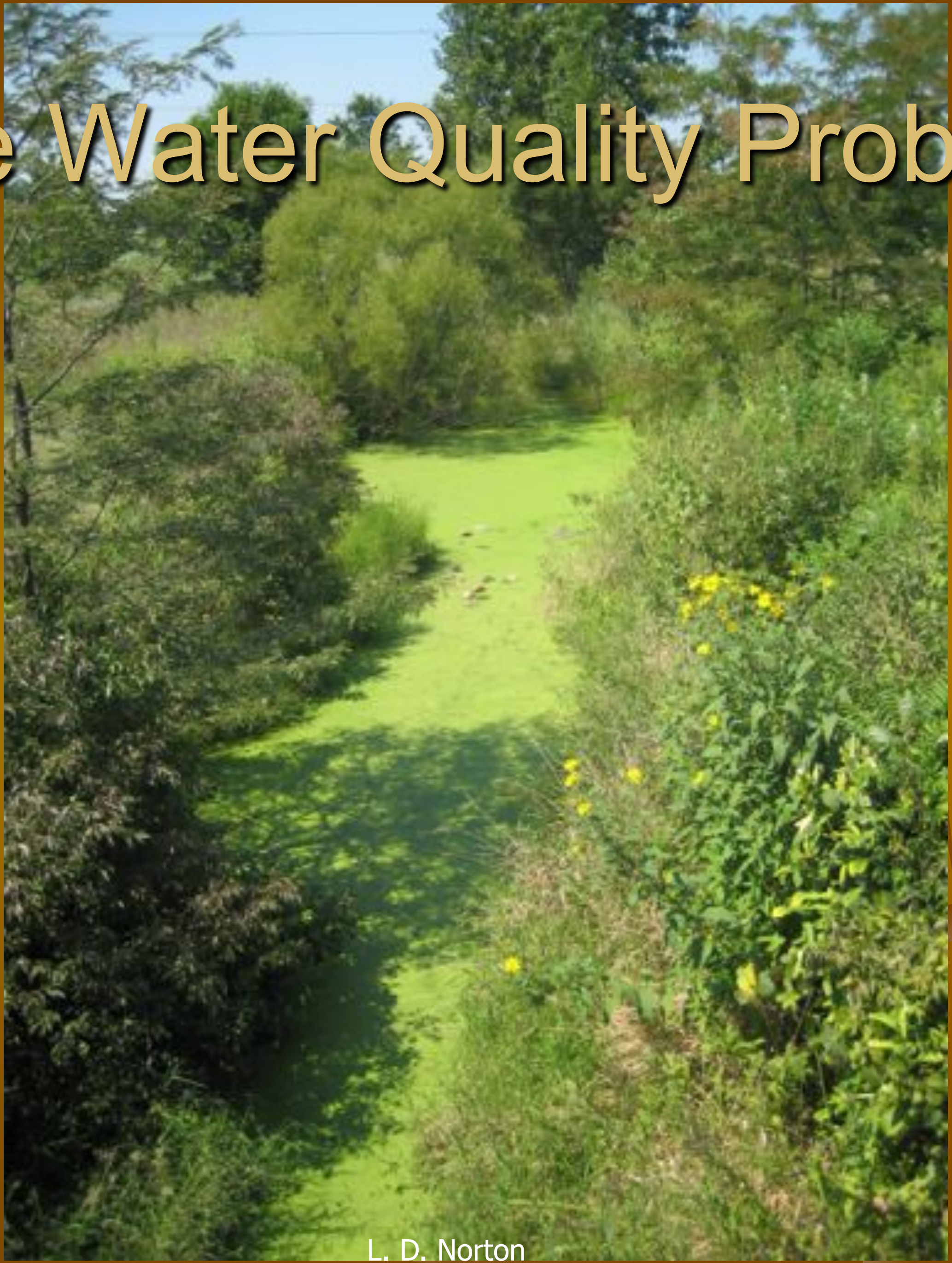
Both Physical and Chemical Processes Occur at the Time Scale of Raindrop Impact

This Leads to Surface Sealing



Runoff Causing Soil Erosion and Removal of Chemicals

Offsite Water Quality Problems



Effect of Degradation by Erosion on Crop Productivity

Electrolyte Sources

- Calcium Sulfate exists is several stable mineral forms
- Gypsum ($CaSO_4$-$2H_2O$) 2.41 g/L
- Anhydrite ($CaSO_4$) 2.09 g/L
- Bassanite ($2CaSO_4$-H_20) 3.00 g/L
- Hannebachite ($2CaS0_3$-H_20) 0.04 g/L
- Calcite ($CaCO_3$) 0.14 g/L

Historical Uses of Gypsum

- Used for over 2000 years by Chinese to coagulate soy milk to make Tofu
- Egyptians used in cement 9000 years ago.
- Greeks and Romans used with volcanic pozzolans to make concrete
- Europeans used gypsum for fertilizer values in 18th Century and brought its use to the USA
- Jefferson and Franklin were among the promoters
- Gypsum use in agriculture in the USA has largely been forgotten except in specialty crops.

Natural Occurring Geologic Deposits

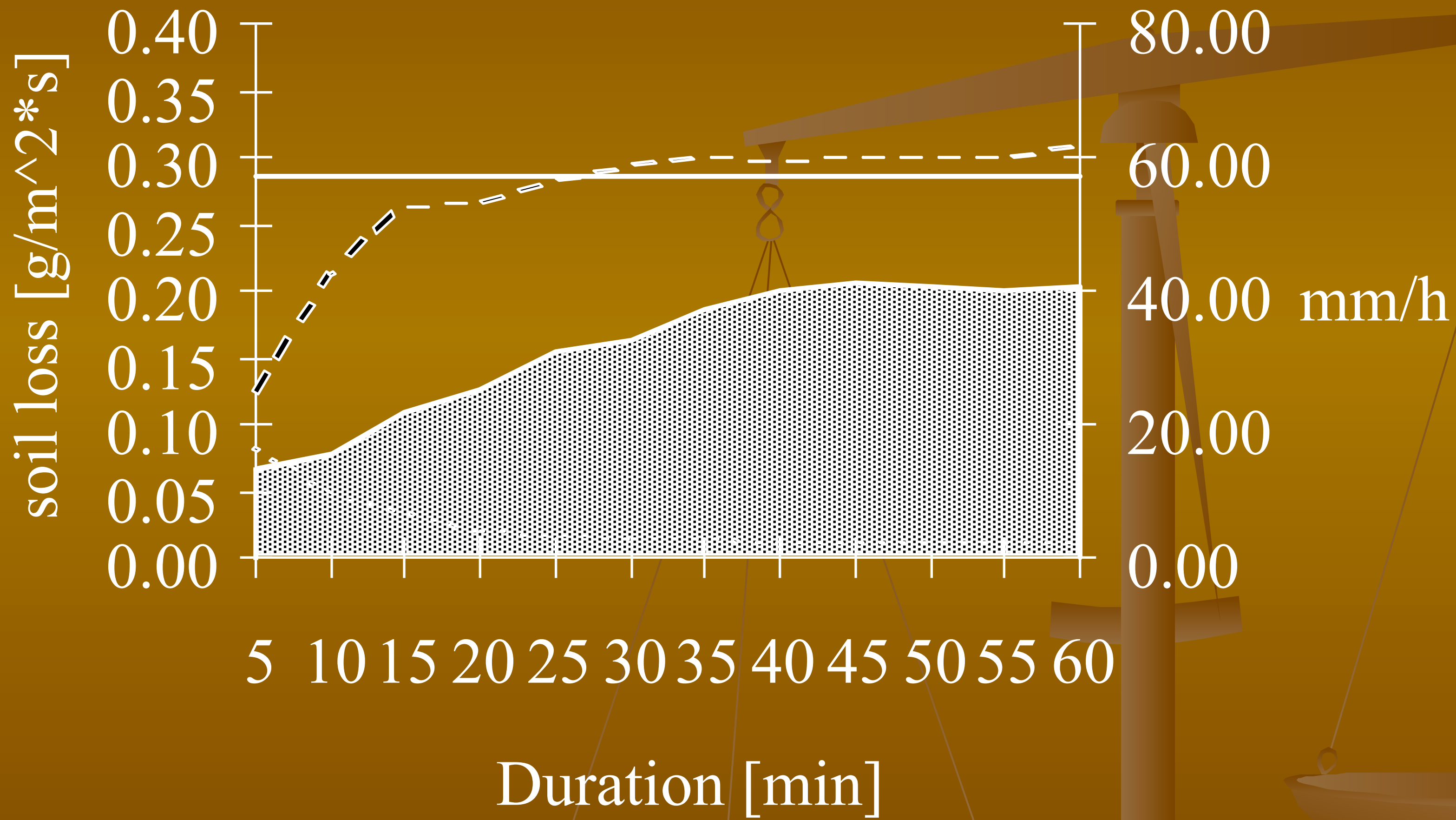
Synthetic Production from Clean Air Regulations

Synthetic Gypsum as a Soil Amendment

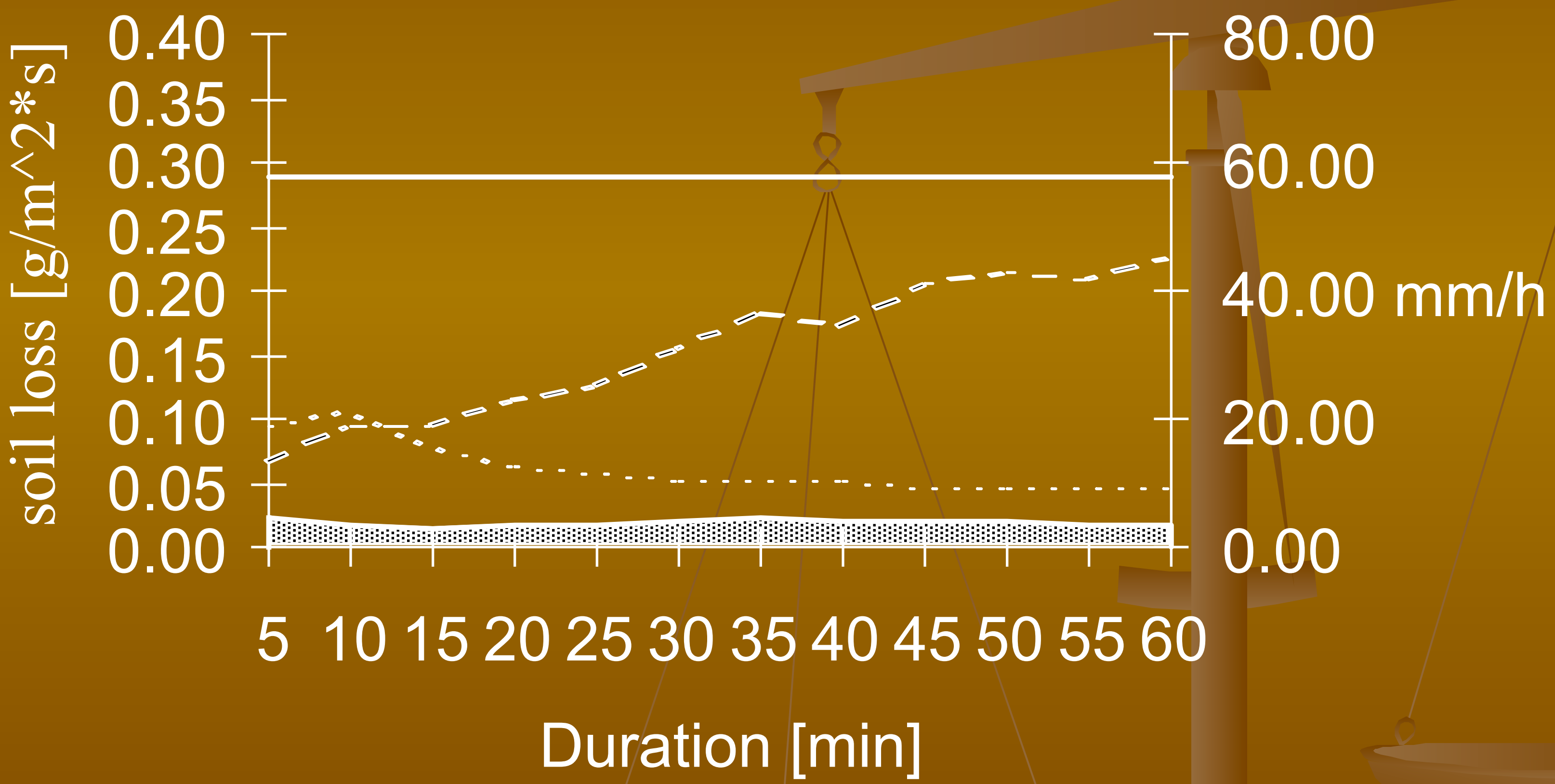
Gypsum Use in USA
Source USGS, 2004

Total use	39,000,000
Mined	18,000,000
Synthetic	11,000,000
Imports	10,400,000
Cement	4,700,000
Agriculture	1,000,000

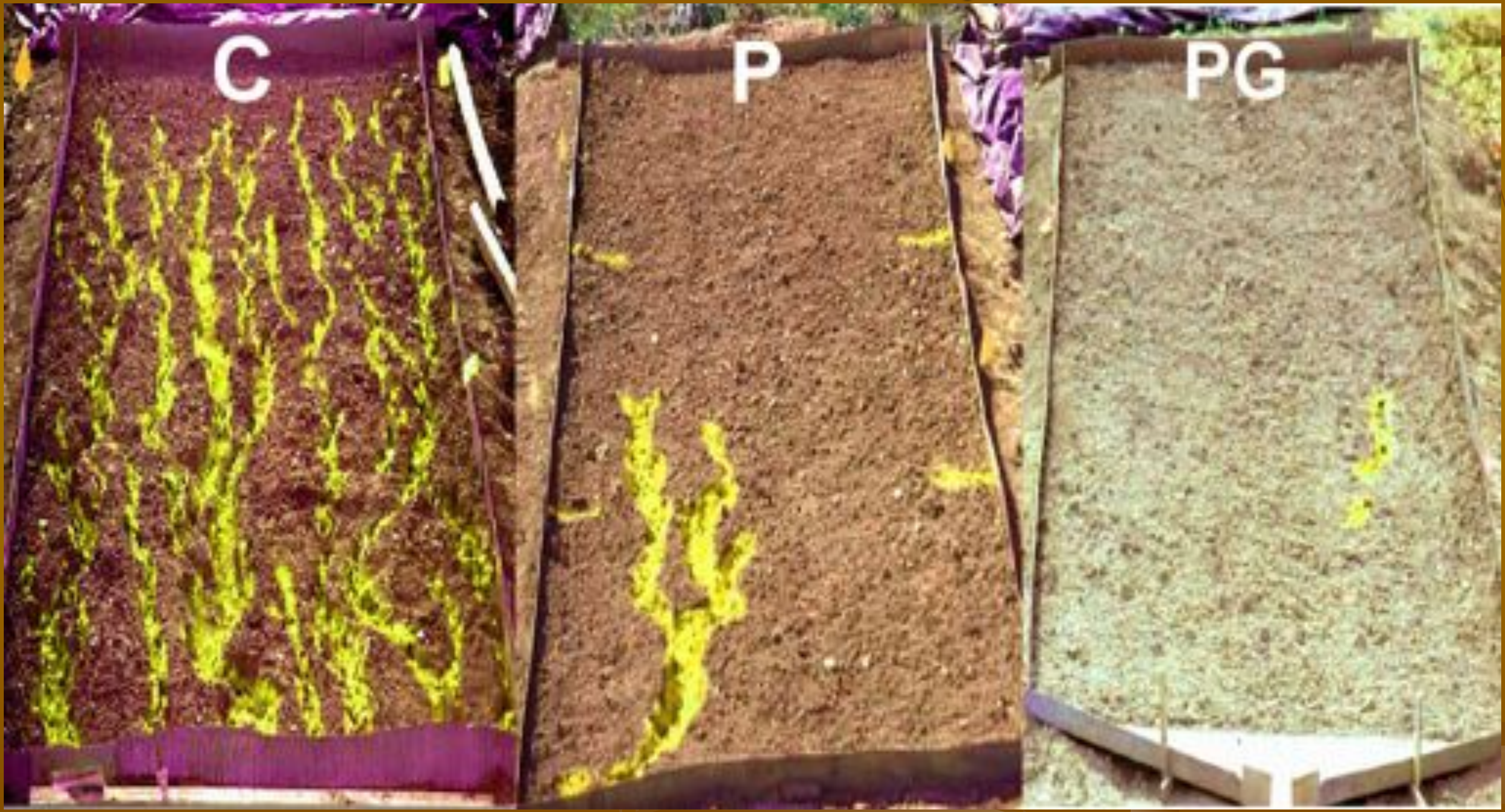
DeWitt, Iowa Site
Fayette silty clay loam



Fayette PAM+FBCBA Treatment



Effect of Gypsum and PAM on Soil Erosion by Concentrated flow on Steep Road Construction Slopes

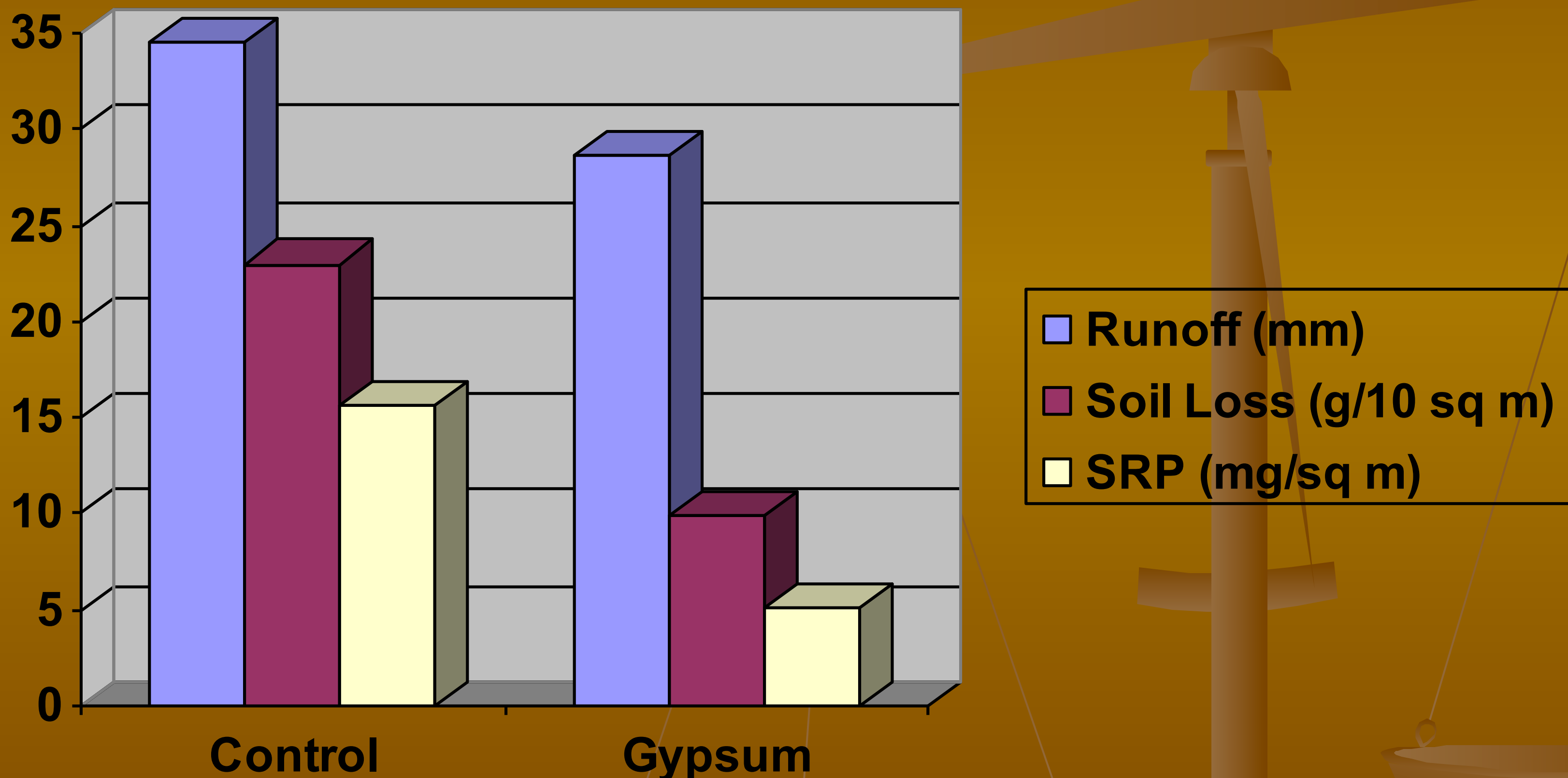


Soil Structural Differences (Control left Gypsum on right)

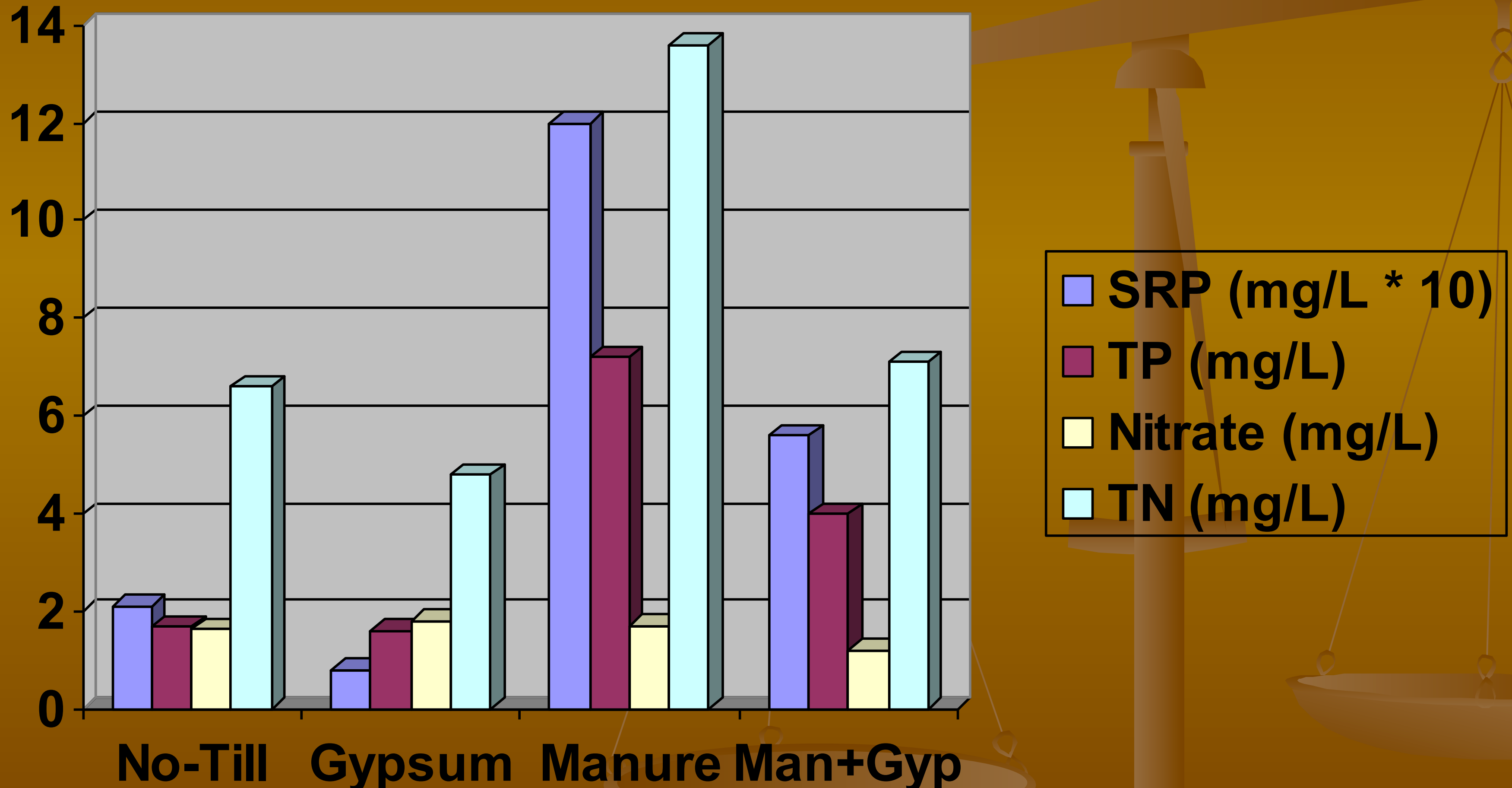
Aggregate Stabilization

Detachment by Flow reduced by Gypsum+PAM

Effect of Gypsum on Erosion



Gypsum Effect on N and P



Conventional No-tillage on Vertisol in Villadiego, MX

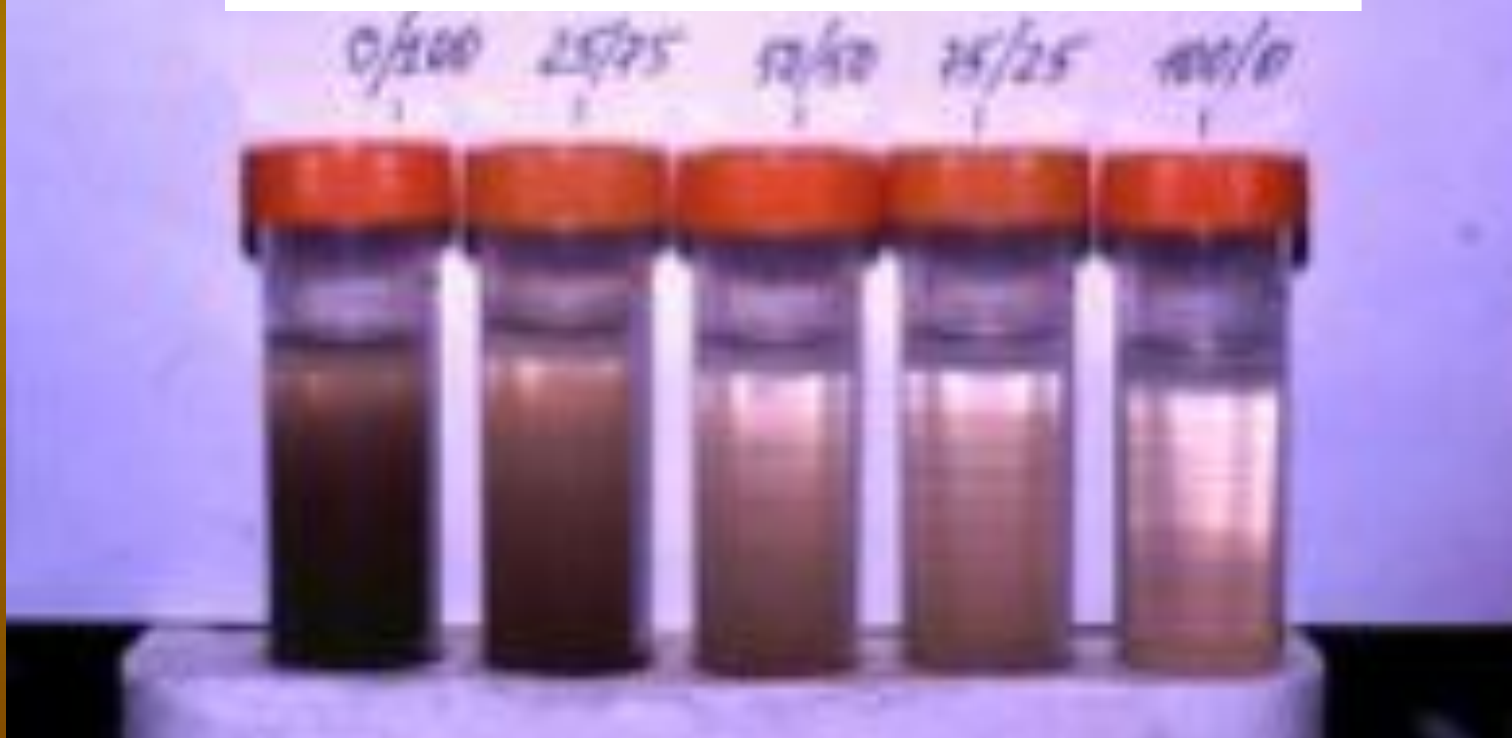
No-Till System with Gypsum on Vertisol in Villadiego, MX

Vertisol with Severe Cracking (Control)

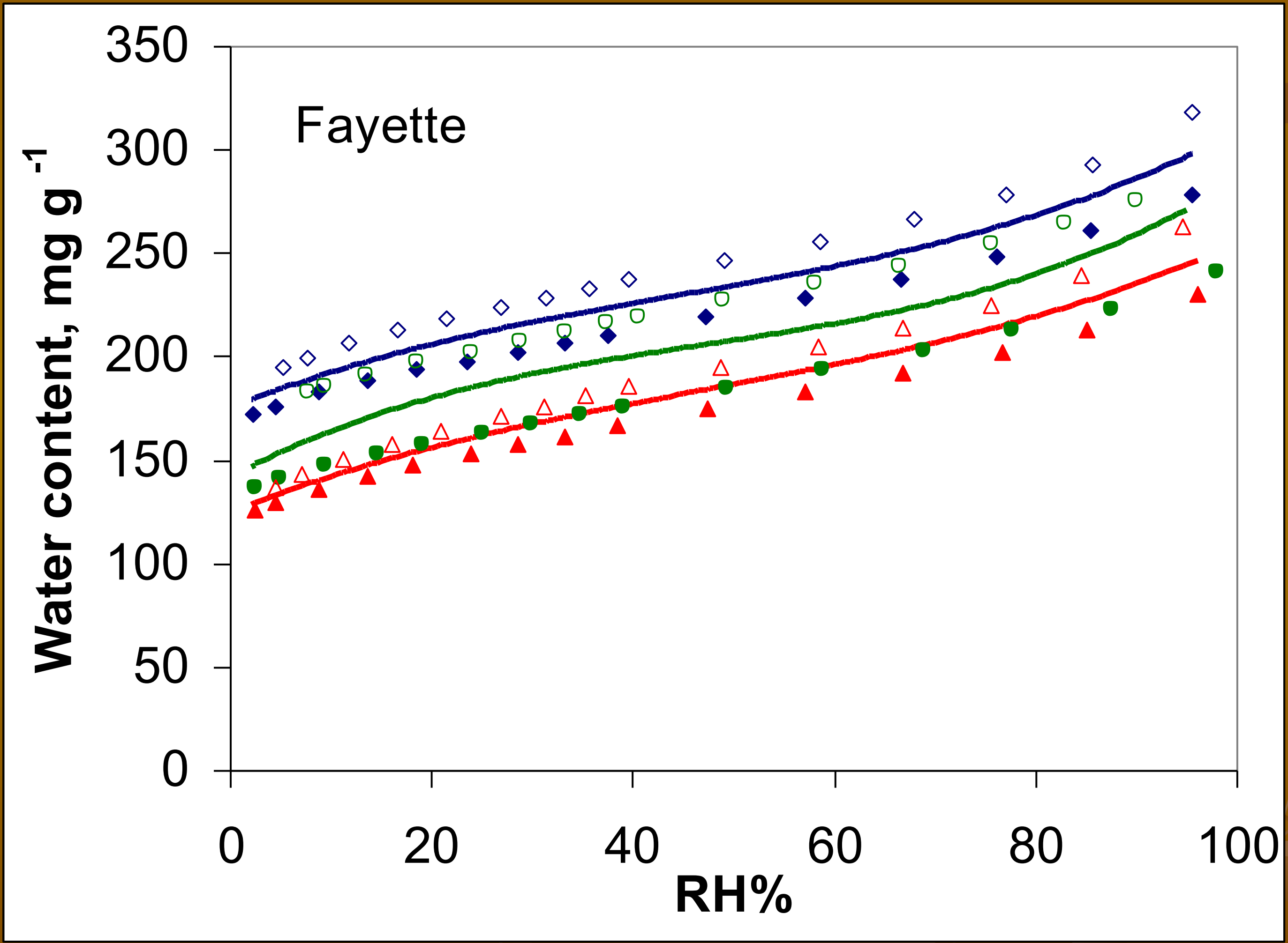
Vertisol Amended with Gypsum

Ca Effect on Flocculation

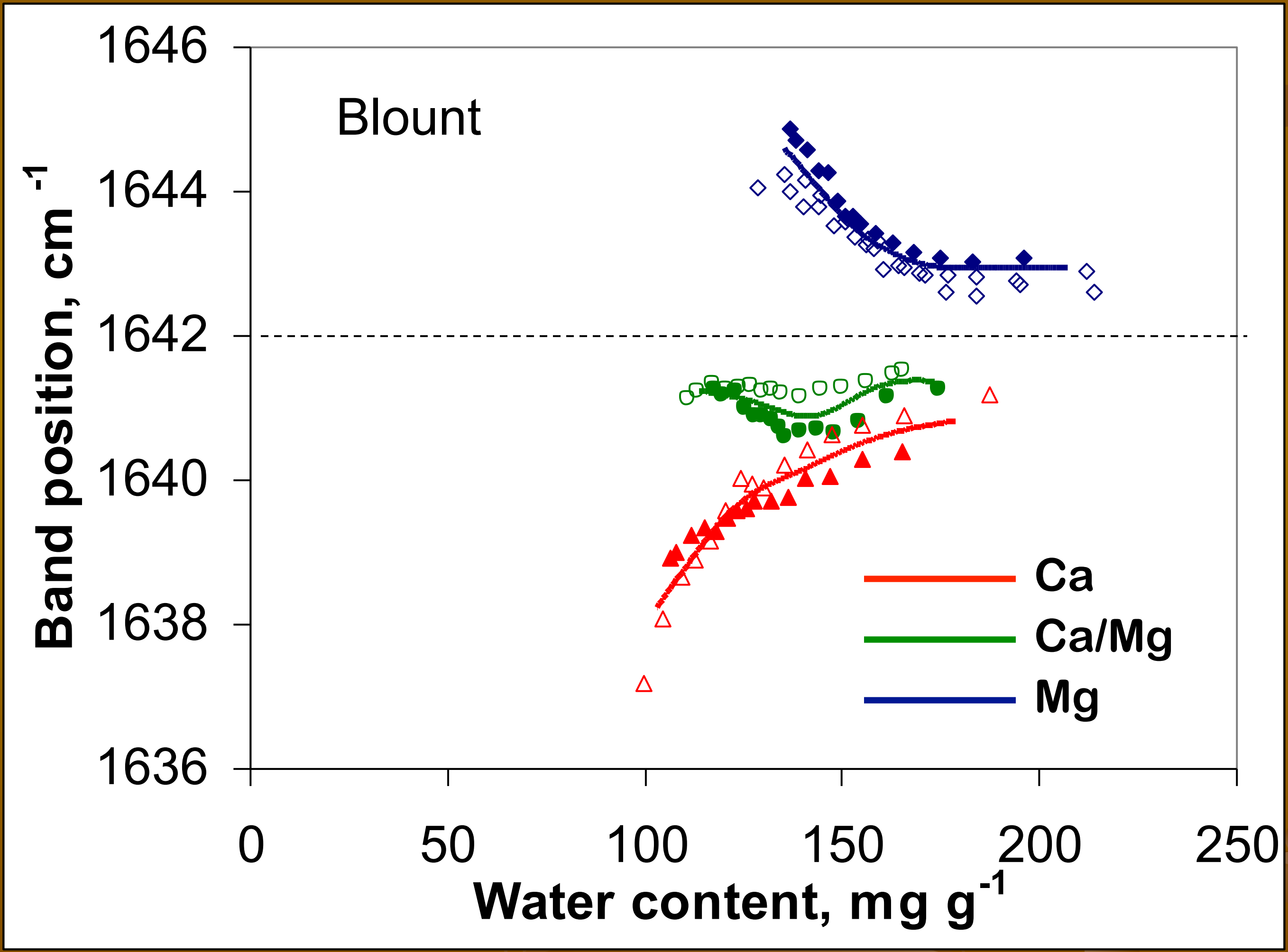
Ca/Mg Ratio has been found to be important in clay flocculation



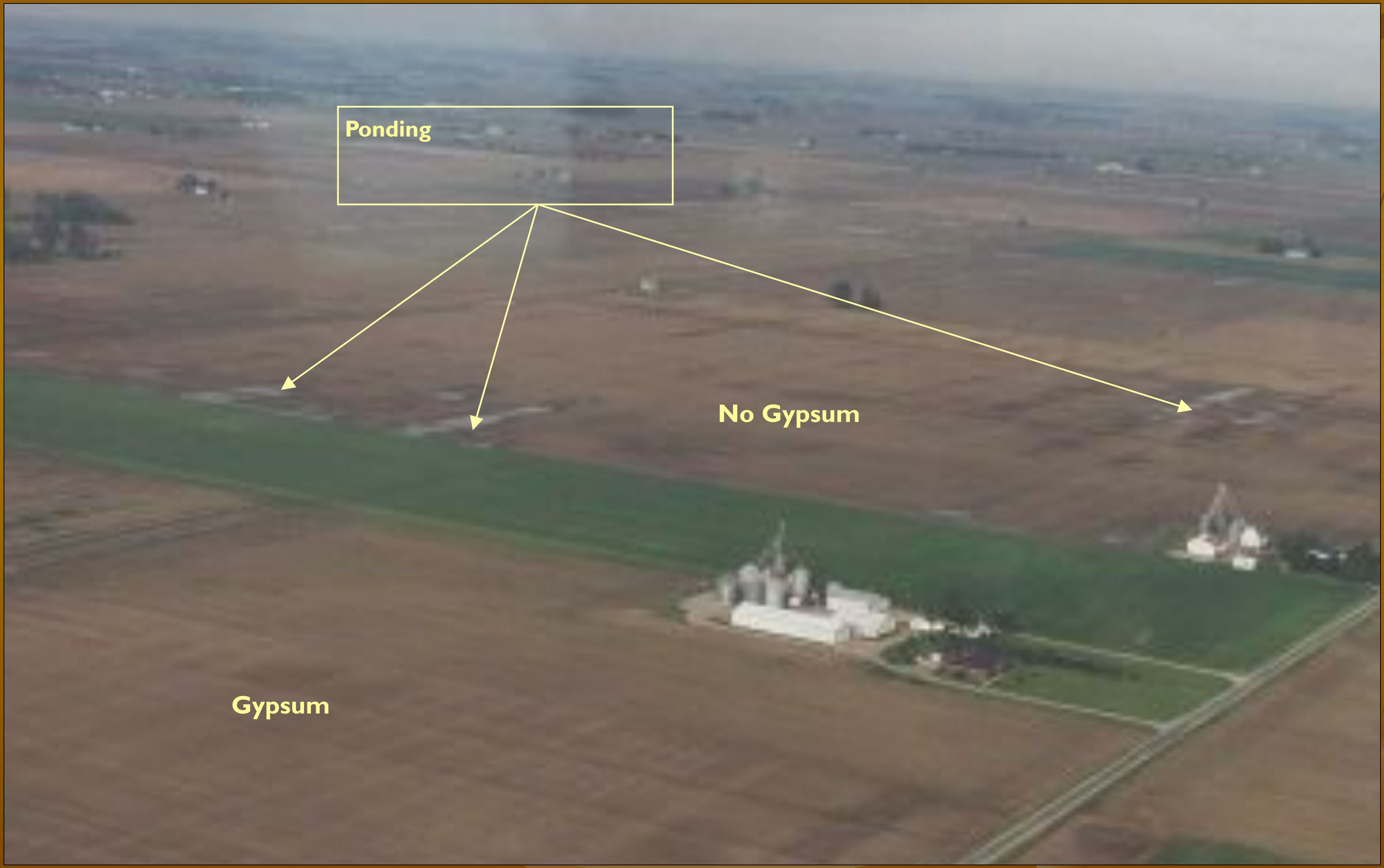
Ion Effect on Water Holding- Smectitic Soil



Ion Effect on Bonding Energy-Illitic Soil



Effect of Gypsum on infiltration/ drainage on a Paulding clay



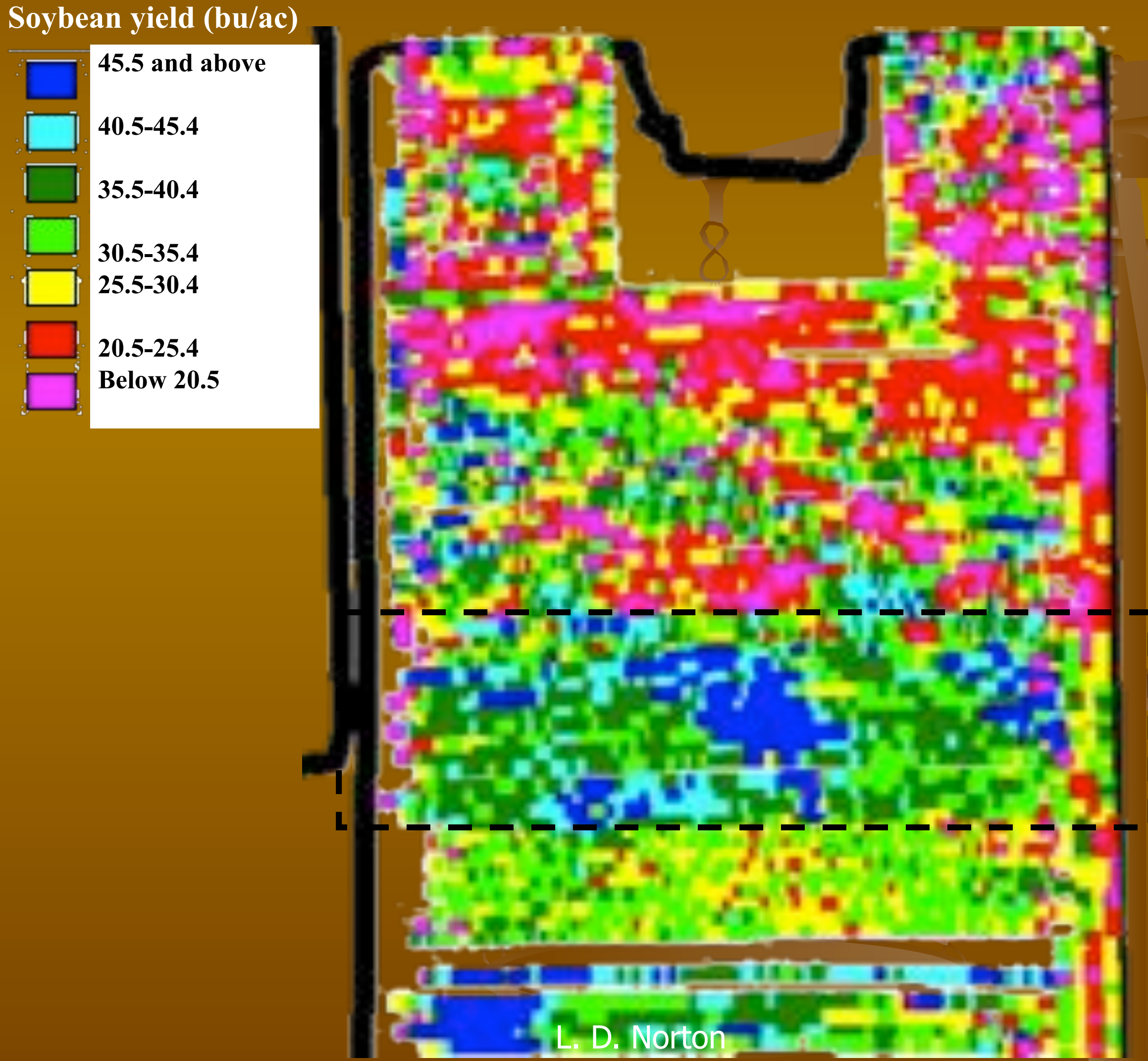
Root Biomass Increased

Gypsum Application on Left w/o on Right

Water Stress Reduced with Gypsum and PAM

Random Corn Ears Amended with Gypsum on Left and Control, Colorado

Soybean yield with 1t/a surface applied gypsum in 2005 on Blount complex field. Treated area inside black dashed line.



RCRA Total Elements in Materials Added (USEPA 3051)

Material	As	Ba	Cd	Cr	Hg	Pb	Se
	ppm	ppm	ppm	ppm	ppb	ppm	ppm
FGD #1	nd	22.2	0.39	7.2	0.1635	nd	3.5
FGD #3	1.4	20.4	0.55	6.8	0.2320	nd	nd
Mined Gypsum	nd	46.6	0.11	2.2	0.0001	nd	nd
Soil	9.4	170.8	1.47	30.3	0.0261	16.06	3.5

Hg in Plant Corn Tissue Kingman, 2008

Type	Trt	Hg (ppb)	S (ppm)	N(%)	C (%)
Ear Leaf	None	4.88	2245	2.99	44.20
Ear Leaf	2000 FGD	6.30	2855	2.84	43.16
Ear Leaf	2000 PG	4.51	2575	2.92	43.29
Stover	None	6.29	1159	0.73	44.15
Stover	2000 FGD	6.20	927	0.70	36.03
Stover	2000 PG	6.52	1185	0.73	44.21
Grain	None	2.31	1095	1.37	44.34
Grain	2000 FGD	3.22	1135	1.36	44.24
Grain	2000 PG	3.28	1129	1.33	44.06

Kingman, IN Hg in Water -60cm 2008

Date	Rate (lbs)	Product	pH	pg/g Hg
7/18/2008	2000	FGD	7.11	17.09
7/23/2008	2000	FGD	7.53	19.54
7/18/2008	0	None	7.41	28.37
7/23/2008	0	None	7.8	67.98
7/18/2008	2000	Mined	7.29	65.32
7/23/2008	2000	Mined	6.8	18.96

Kingman, IN Hg in Water -60cm 2009

Date	Rate (lbs/ac)	Product	Ppt
			Hg
6/26/2009	2000	FGD	15.28
7/17/2009	2000	FGD	9.65
6/26/2009	0	None	22.06
7/17/2009	0	None	7.26
6/26/2009	2000	2000	10.95
7/17/2009	2000	2000	13.12

Hg in Runoff Water Kingman, IN 2009

Plot	Trt	Hg Conc. ppt	Average
6	Control	18.6	12.24
10	Control	6.4	
15	Control	11.8	
1	6000 lb/ac Fly Ash	11.7	9.88
7	6000 lb/ac Fly Ash	10.2	
14	6000 lb/ac Fly Ash	7.8	
8	6000 lb/ac FGD	25.1	24.08
9	6000 lb/ac FGD	18.4	
11	6000 lb/ac FGD	28.7	

Hg uptake in Corn Shoots after six weeks growth with perched water table

Drainage condition	Treatment		Hg ppb	
Freely Drained	Control		4.57	a
	FGD Gypsum		3.75	a
	Glyphosate		6.43	a
	FGD Gyp.+Glyph.		4.13	a
Perched water table (-5cm)	Control		55.92	b
	FGD Gypsum		61.88	b
	Glyphosate		61.98	b
	FGD Gyp.+Glyph.		64.54	b

Conclusions

- FGD gypsum has a multitude of uses in agriculture
- Reduced soil erosion and runoff
- Improvement of physical properties
- Ca and S Fertility
- Improved water quality
- Potential for improved N and P efficiency
- FGD Gypsum has no significant uptake in corn on adverse potential to water quality for a poorly drained midwestern soil.
- Improved yields and sustainability of agriculture

Questions?