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Genesis and Evolution of Black Soil in the Eastern Mediterranean

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Soil fertility degradation in the Middle East…myth or reality?

- **The environmental history of the Middle East is not an issue of a fertile land becoming desert. Most of it is desert and it always has been.**
- **The precious rain from the Mediterranean falls for 100 km or so from the coast, creating some fertile areas, as isolated islands that were not desert and they still are not.**

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- **However, whatever the definition is used, there is quite a lot of desert impact in the equation (evaporation, aeolian dust).**

The Eastern Mediterranean

- ✓ Located in the eastern corner of the Mediterranean Sea
- ✓ Submitted to Mediterranean climate condition with meld wet winter and hot dry summer
- ✓ The soil is red Mediterranean (terra rossa) with red color and poor of organic carbon and high of carbonates

Black Soil in the Eastern Mediterranean

The occurrence of such soil is occasionally in Mediterranean because of the climate condition with xeric moisture and thermic temperature soil regimes, which is not favorited for forming and developing such kind of soil

However, it is still occurring at a less extending in different climatic zones from xeric to aridic and called **SAWDA'A**

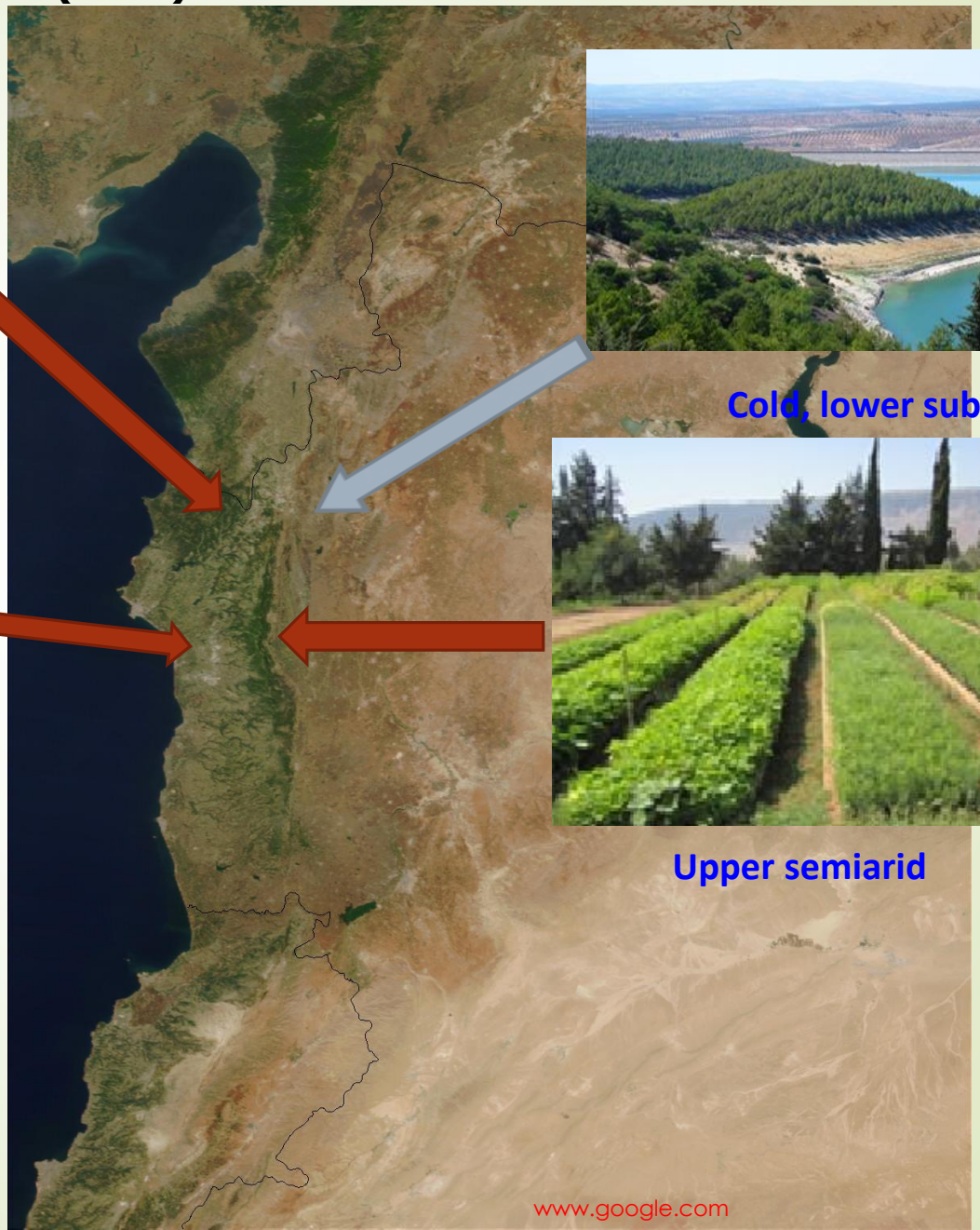
Their current occurrence rise many questions about the conditions of formation and type of paleoclimate that prevailed

Theories on their formation in the Mediterranean region are not in general agreement

The black soil was studied at five bio-climate areas according to Pluvio-thermic Equation of Emberger (1955):

Upper humid

Fresh and temperate



Cold, lower sub-humid

Upper semiarid

Martials and Methods

These areas submitted to meditteranian climate, frish winter, hot dry summer with annual precipitation from 200 to more than 1000 mm

The soil moisture regime is xeric and the temperature soil regime is thermic

Climax vegetation is
-Pinus brutia forest;
-maquis mainly Quercus in wet areas.
-Laurus nobilis, Pistacia, Myrtus, Olea europea in moderately wet areas,
-Tamarix ssp in areas with less than 200 precipitation areas

16 soil profiles of black soil of different topography were studied from different bio-climate areas and on different parent materials (Calcareous sand, Lacustrine marl , Limestone, Dolostones, …..)

Profile Cod	Coordinates		Elevation m. a. s. l
	N	E	
Jableh	35°25'10.67"	35°55'23.37"	28
Al Qanjra	35°37'43.7"	35°49'40.13"	10
Kassab-Zanzaf	35°47'44.77"	35°55'46.52"	240
Kasab Nibh Almur	35°52'41.93"	35°59'35.60"	380
Kassab	35°54'47.54"	35°59'24.10"	800
Der Autman	35°58'22.8"	36°19'16.2"	325
Drkosh-Al-daher	35°58'04.8"	36°25'37.9"	530
Akkar-Zahed	34°41'38.66"	35°59'12.36"	18
Barshin	34°52'20.60"	36°20'37.41"	930
Houla	34°53'42.88"	36°32'11.59"	375
El Ghab-Joureen	35°31'58.92"	36°15'7.67"	183
El Ghab-Ennab	35°25'25.40"	36°14'41.89"	182
El Ghab-Al Kareem	35°23'48.30"	36°19'49.73"	178
El Ghab-Qarqor	35°43'58.76"	36°19'13.47"	170
El Ghab-Mshik	35°42'20"	36°20'26.7"	175

Soil describing and sampling was based on procedures of Soil Survey Division Staff (1993). The morphological study and soil profile description were based on field book for describing soils U.S.D.A-NRCS (1998). Laboratory analysis included

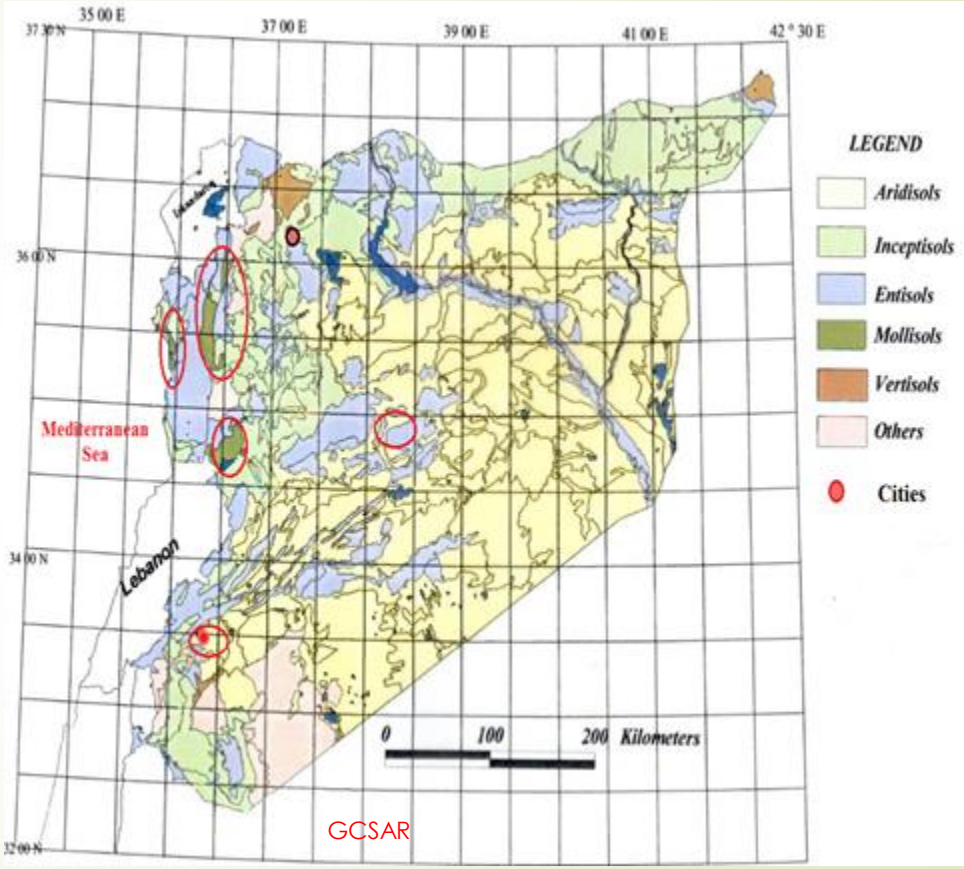
- Organic carbon (Corg.)
- The particle-size analysis
- Soil reaction (pH)
- Exchangeable cations
- Calcium carbonates
- Total Nitrogen
- Electrical Conductivity (EC)
- Available phosphorus
- Total potassium

The results

The investigated of the black soil in the eastern Mediterranean can be suggested two soils types:

1-Calcareous black soil (Rendzina) on littoral plains and hilly areas,

2- Hydromorphic black soil,



Jableh

Classification USDA(2003): Typic Rendolls

WRB (2015) Rendzic Leptosols

Location: Lattakia Governorate, Syria. Jableh.

Coordinates: $35^{0}25`10.67N35^{0}55`23.37E$

Altitude: 28 m a. s. l

Physiography: Flat plain

Drainage class: Moderately well drained, very slow surface run off

Vegetation: Cultivated citrus trees

Parent material: Conglomerates calcareous, sandstone

Date of Sampling: June 20-2007

Horizon	Depth (cm)	Description
Oi	0-5	**Very dark gray (10YR 3/1 d) to black (10YR 2/1 m)** slightly decomposed plant material; slightly plastic; frequent, rounded stone, constituting approximately 10 percent of the horizon; abundant very fine to medium roots, mostly inside peds; abrupt smooth boundary
A	5-35	**Very dark grayish brown (10 YR 3/2 m)** massive; weak, fine, subangular blocky structure; firm (moist), sticky and plastic;; few, very fine and fine, discontinuous, irregular, simple, open pores; few, fine and very fine roots, mostly inside peds; clear, wavy boundary
A2	35-50	Dark red (2.5Y3/6 d) fine granular structure; few, fine, vertical, inped, simple, closed pores; few, small, soft, carbonate stones; few fine roots, inside peds; very abrupt, smooth boundary
C	50+	Conglomerates calcareous, sandstone; very pale brown10YR8/2, pink 7.5YR8/3

Jableh: physical and chemical analysis

Horizon	Depth (cm)	$CaCO_3$ %	pH ($CaCl_2$) 1:1	pH (H_2O) 1:1	Particles size distribution (%) Ø mm			Texture	$C_{org.}$ %
					Sand	Silt	Clay		
Oi	**0-5**	**2.2**	7.42	7.54	54	16	30	**Sandy clay loam**	**4.42**
A	**5-35**	**16.4**	7.64	7.8	60	14	26	**Clay loam**	**2.41**
A2	35-50	29.5	8.1	8.2	46	22	32	Sandy clay loam	0.9
C	55+	44.0	7.42	7.54	40	40	20	Sandy clay loam	0.1

Horizon	Depth (cm)	Av.K $mg.kg^{-1}$	Ext. P $mg.kg^{-1}$	Tot-N %	Min- N $mg.kg^{-1}$	EC 1:2 $dS.m^{-1}$	CEC $meq.100g^{-1}$	BS
Oi	0-5	-	31.3	0.38	-	0.5	**52.5**	100
A	5-35	-	20.5	0.19	-	0.4	**62.5**	100
A2	35-50	-	29.0	0.08	-	0.4	67.9	100
C	50+	-	19.0	-	-	0.3	70.2	100

El Ghab

Classification USDA(2003): Patchic Haploxeroll,

WRB (2015): Calcic Chernozems

Location: El Ghab plain, Syria.

Coordinates: $35^{0}42`20N\ 36^{0}20`26.7E$

Altitude: 175 m a. s. l

Physiography: Level to depressional valley fills

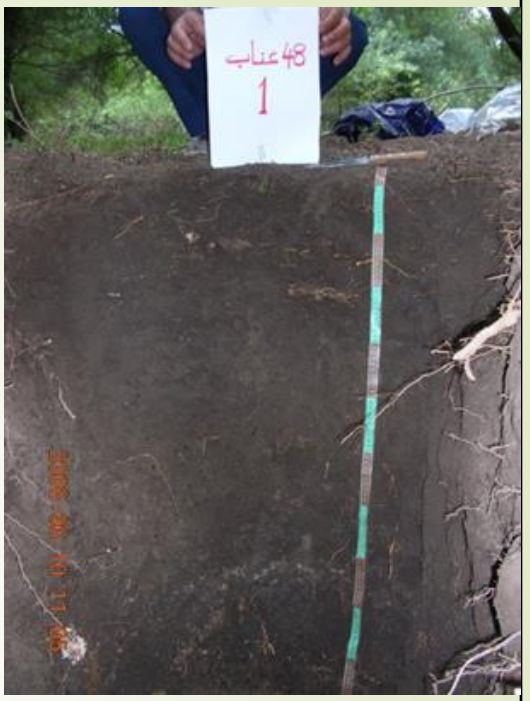
Topography: Level topography with a characteristic slope of 1 percent or less

Drainage class: Moderately well drained, very slow surface run-off, slow permeability

Vegetation: Elms trees

Parent material: Marl and Quaternary or more recent lacustrine deposits.

Date of Sampling: July 16-2010



Horizon	Depth (cm)	Description
A	0-26	**Black (10 YR 2/1m), Dark brown (10 YR 3/3 d)** midrate, medium, **granular structure**; soft (dry), slightly firm (moist), sticky and plastic; many, fine, horizontal, inped, simple, open pores; plenty, fine roots, between peds; abrupt, smooth boundary
A2	26-55	**Very dark brown (10 YR 3/2 m) fine granular structure**; firm (moist) sticky and plastic; few, fine, vertical, inped, simple, closed pores; plenty, fine roots, between peds; gradual, wavy boundary
AC	55+	Grayish brown (10 YR 4/1 m) massive structure; firm (moist), sticky and plastic; few, fine, vertical, inped, simple, closed pores; few, small, soft, carbonate accumulations on ped faces; few fine roots, inside peds

El Ghab: physical and chemical analysis

Horizon	Depth (cm)	Particles size disruption (%) Ø mm			Texture	$C_{org.}$ %	pH H_2O 1:1	Carbonates as $CaCO_3$ %		CEC Cmol.kg^{-1}	BS
		Clay	Silt	Sand				<2mm	<0.002mm		
A	0-26	28	26	46	**Sandy clay loam**	**4.2**	7.23	41.0	17.0	**42**	88.2
A2	26-55	18	34	48	**Loam**	**3.1**	7.86	52.5	27.0	**24**	88.3
AC	55+	30	24	46	Sandy clay loam	2.2	7.64	76.0	26.0	22	75.7

Horizon	Depth (cm)	Extractable bases meq.100g-1			Ext. P2O5 mg.kg-1	Min- N mg.kg^{-1}	EC mS.m^{-1}
		Ca	Mg	K			
A	0-26	28.0	8.0	0.2	11.8	2	1.6
A2	26-55	15.0	1.1	0.1	8.2	4	2.1
AC	55+	11.0	0.6	0.1	3.3	2	2.5

TOPSOIL MORPHOLOGY; PYSICAL AND CHIMECAL PROPERTIES

Soil color
Rnages between 10 YR 2/1 moist to 10 YR 4.5/4 dry

Soil texture
Clay, Sandy clay loam to silty clay loam

Soil organic carbon
4.42 to 1.71%

Soil CEC
32.8 to 52.5

Soil structure
Midrate medium fine granular, sub angular to massive

pH
5.8 slightly acid to 8.1 Moderately Alkaline

Discussion

1- Calcareous black soil (Rendzina) on the littoral plain and hilly areas

- ✓ occur in a humid and sub-humid Mediterranean climate, annual precipitation exceed 800mm
- ✓ Developed on limestone, sandstone, chalk, dolostones and smellier calcareous materials
- ✓ High organic carbon content as well as high carbonate content like the entire of soil profile
- ✓ High calcium carbonate content kept the soil almost completely base saturated, ……retarding weathering and subsequent release and redistribution of sesquioxides and silica……. weak developed, immature profile.

Calcareous black soil (Rendzina) on the littoral plain and hilly areas

The dominated soil is Typic Rendolls (The Proper Rendzina) that has developed from Brown Calcisols or directly from calcareous regolith

Rendzina on chalky marl is at more advanced development stage.

The soft weathering parent material permits to developing a relatively thick profile, with developing of a primitive illuvial zone or micro B horizon.

ST: Typic Calcixerolls
WRB: (Somerirendzic) Calcaric Leptosols

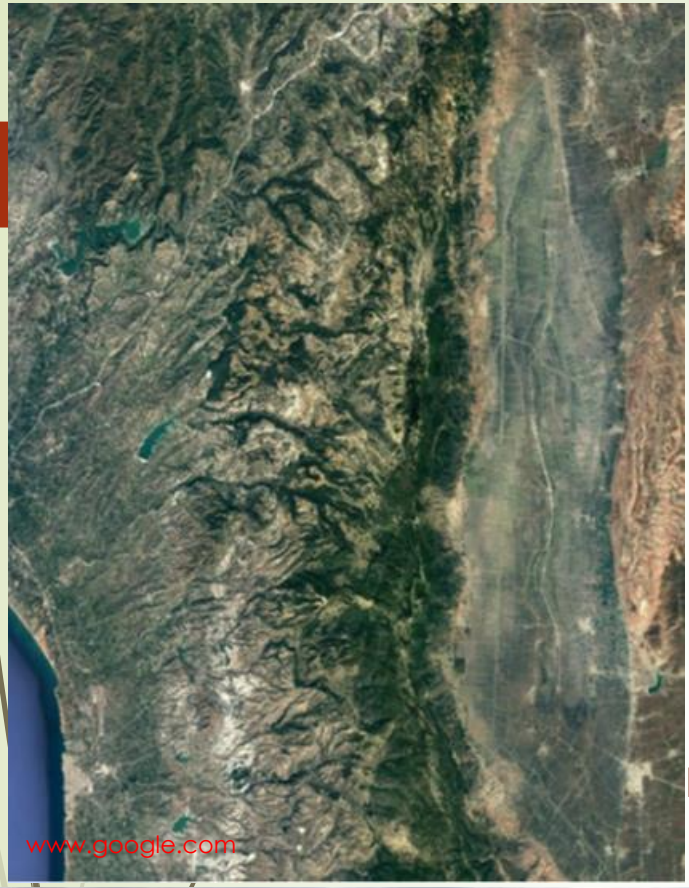
Brown rendzina on Lemestone	Gresish rendzina on Serbantenes	Redish rendzina on Dolostone	Para rendzina on steep slope
Clacic Pachic Hapoloxerolls **Leptic Kastanozem**	**Typic Rendolls** **Rendzic Leptosols**	**Entic Hapoloxerolls** **Rendzic Humic Leptosol**	**Ain Al Beida** **Calcaric Leptic Regosols**
			

Hydromorphic black soil

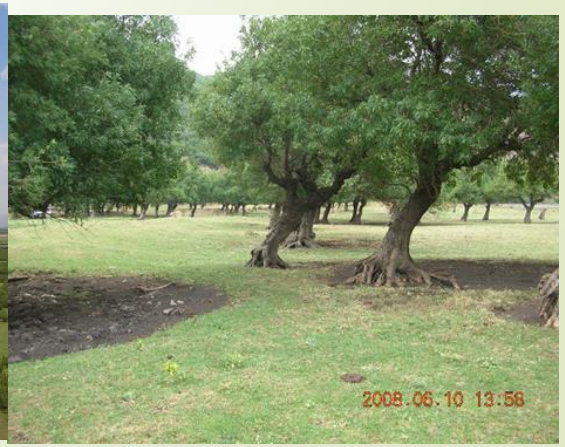
- ✓ This soil is the most important in terms of extension and terms of agricultural use.
- ✓ The annual precipitation ranges from 500 to 1000 mm.
- ✓ The hydrologic conditions play drive role in the evolution and developing, (bad drainage ….heavy clayey, very slow runoff

Theses associated with the extension of the great African-Syrian faults (the dead sea fault) along the eastern coast of the Mediterranean, led to the emergence of many depressions (Jordan valley, Hola Galilea, Houla plain, El Beqaa valley, El Ghab rift valley, El Amuq rift valley).

- ✓ Water stagnation and bad drainage had their roles in the accumulation of organic matter on the topsoil to the extent that these soils were wetlands before artificial drainage



Black soil in El Ghab Valley



- ✓ Field and the morphological data show that the soil receives more moisture (ground moisture) than the prevailing moisture regime suggests.
- ✓ Thickness of mollic, occurrence of carbonate, the level of water ground …..are features assist in soil classification at the lower categories, as such Aquic, Cumulic, Pachic, Clacic pachic, and Typic Haploxerolls are assumed to be largely represented,

			
Joureen Aquic Haploxerolls	Ennab Cumulic Haploxerolls	El Kreem Pachic Haploxerolls	Nbel El Khateeb Calcic Haploxerolls

Conclusions

- ✓Black soil was extremely extended in the eastern Mediterranean area. However, it is still occurring at a less extending in different climatic zones from xeric to aridic
- ✓The existing of such kind of soil under arid and semi-arid conditions, raising a question about the geneses and forming process and condition associated particularly paleosols and paleoclimate, which requires further researches
- ✓ In our study two types were found: Rendzina soil, and Hydromorphic black soil.

- ✓The Hydromorphic black soil seems to be the oldest soil, while the rendzina is the most recent one.
- ✓Rendzina occurs on limestone, sandstone, chalk, dolostones, and smellier calcareous materials with the dark surface horizon and high carbonate content, this kept it completely base saturated.
- ✓This soil weak developed, has immature profile and with domination of Proper Rendzina (Typic Rendolls).

Thank you