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Surface-Subface Geochemical and Mineralogical Study of Gypcrete in Alexandria Area Central Iraq

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Abstract:

Gypsiferous soil deposits (Gypcrete) are weakly consolidate earthy mixture of secondary gypsum, sand and clay. It is formed in arid and semi- arid area with annual precipitation rainfall less than 400mm. These sediments occur in surface and subsurface in region of little rainfall and rapid evaporation. This research deals with the study of gypcrete in Alexandria to improve the mineralogical and geochemical properties of the gypcrete. The gypcrete soil is used as raw material to produce the plaster for building purposes. Three samples of gypcrete were chemically and geochemically analyzed.

The common mineral is howed in 0-0.5m Gypsum followed by Calcite in 0-1m and Quartz in 1-1.5m due to leaching and infiltration by rainfall as well as it full the clay Matrix and the voids between soil constituent, therefore soil properties changes with depth and the clay materials increases such as (Al, Na and K oxides) and Gypsum compound decreases (Ca, S and Sr oxides), yet the change in element concentration, takes the same path. This indicate that annual season rainfall is the only factor affecting mineralogy in this arid area and this means that the Gypsum concentration cannot be affected by ground water either increasing or decreasing. This research concerns about mineralogy and element occurrence variation in this material with accordance to their concentration from surface to depth of 1.5 meter.

Key words: Gypcrete, soil, depth, environment, leaching by rainfall and groundwater..

Introduction

Gypsum is one of the important non-metallic minerals, composed of hydrated calcium sulphate ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$). It contains 79.1 % calcium sulphate, 20.9% water [1]. Primary gypsum within Al-Fatha Formation has been precipitated by sea water, while secondary Gypsum formed

by dissolving primary gypsum rocks at source area and redeposition at younger formation as sediments in Holocene. [2]. The gypsiferous soil (Gypcrete) usually developed in arid and semi-arid area with less than 400mm annual rainfall where abundant sources of gypsum exist and gypsum accumulation

in the soil are related to quaternary deposits more than 1m and in the soil if the depth of the water table is less than 5m [3]. The gypsiferous soil in Iraq is related mainly to the substratum containing gypsum and had prepared soil distribution for the first time, secondary gypsum is concentrated in the middle third and south of Iraq [4]. The main reason for gypsum accumulation in the soil is precipitation from ground water and surface water by strong evaporation. A large part of gypsum accumulation occurs as sub soils, fine-grained soils contain more gypsum than coarse grained soils. Almost all gypsum accumulate above capillary water zone in dry areas at which water table is located (2.5-3) m from surface, ground water will evaporate [3,4]. The gypsiferous soil classified into two types, the first type is the soil which has been subjected to leaching process, removing a large part of gypsum and soluble salts leading to change the distribution of them. The second type represented soil that not subjected to complete or partly leaching process and their distribution remained unaffected [5]. Petrographic study and XRD study showed that gypcrete consists of gypsum, quartz, feldspar, Calcite, biotite, rock fragment and heavy minerals. Chemical analyses showed that the content of gypsum in the gypcrete in Alexandria locality in Babylon governorate is not suitable for production of a good quality plaster. Table 3. Three samples were selected from seven sites at the depth (0-0.5), (0.5-1), (1-1.5)m showed that gypsum was dominated mineral in the studied area followed by calcite in the (1-1.5)m but the percentage quartz increases with depth to 13.2% in the depth (1-1.5) m [6,7]. The oxides of high percentage in the surface (0-0.5) in (Ca, Sr, S oxides) decreases with depth, but (Al, Na, F, K, Mg, Ti, C oxides) increases because these are mainly cons-

tituents of soil which increases with depth compared to gypsum minerals [8]. Element analysis chemically showed that concentration varied with depth (As, Bi, Hg) decreases while (En, Er, Dy, Cs, Cr, Ce, Ba, C, Nd, Nb, Lu, La, Ho, HF, Cd, Ca, Th, Tb, Ta, StSn, Sm, Pt, Sb, Zr, Yb, Y, W, V, U, Tm, TI(etc) increased [9]. Table 4. This can show the origin of secondary gypsum in the studied area formed by dissolving primary gypsum and redeposition from the surface water at younger formations in the arid and semiarid area that means effect of ground water is minor or neglected. [10,11]. The aim of the present research is to study the relation between distribution of elements with depth and their relation to environment, also to confirm the formation of gypsum in this area.

Materials and Methods:

The field work of gypcrete soil was carried out in Alexandria including sampling of the gypcrete soil from seven sites by selection of 3 samples collecting according to change in gypsum content or lithological changes. (A1=(0-0.5m, A2=(0.5-1m, A3=1-1.5m) crushing the samples with notification of inhomogeneous crushing then keeping them in plastic bags labeled. These samples are suitable for chemical and mineralogical analysis after figuring.

Petrographic study

Because of the variable nature of most gypcrete sample impregnated in (aradite) (AY105) and hardness (H Y 930) following the method of Moorland (1968 in Hatchison 1974) and samples were collected by using point counter mechanical stage as suggested by Chayes (1949). This work was done in the Laboratory of Collage of Science Department Of Geology \University Of Baghdad.

Table 1: petrographic study results (%) as revealed by thin suction examination off gyp-crete at the depths A1, A2 and A3.

The component's	A1	A2	A3
Quartz	4.90	6.79	13.2
Feldspar	1.95	1.94	2.65
Gypsum	63.7	48.5	8.84
Carbonate R. F	7.84	14.5	44.2
Chert R. F	---	0.9	1.76
Argillaceous R. F	1.96	3.8	-----
Matrix	9.80	9.7	10.6
Cement	6.86	7.7	8.84
Opques Grains	1.96	2.9	3.53
Others	0.98	0.9	1.76

Mineralogical analysis using X-Ray diffraction (XRD):

Three bulk samples of gypcrete where tested using X-Ray diffraction (XRD) instrument in the laboratory of Iraqi geological survey.

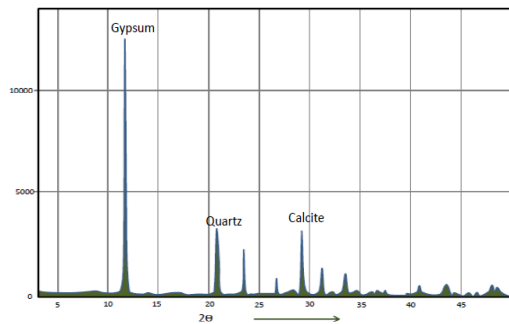


Fig.(1)A1:Diffractogram of the raw material of Alexandria area in site A, sample A1.at depth(0-0.5)

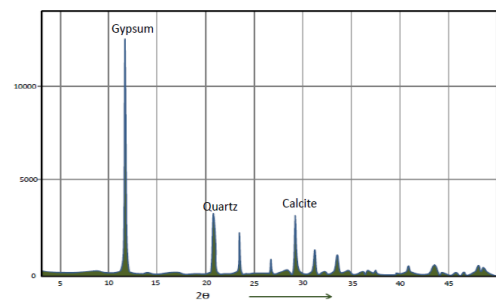


fig.(2)A2:Diffractogram of the raw material of Alexandria area in site A, sample A2.atdepth (0.5-1)

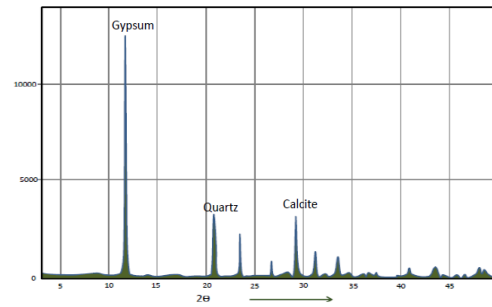


Fig.(3)A3: Diffractogram of the raw material of Alexandria area in site A, sample A3.at depth(1-1.5)

Table 2: Mineralogical Analysis (XRD)of gypcrete form Alexandria at depth(A1,A2,A3)

Sample	A1	A2	A3
Mineralogical analysis byXRD-6000	Gypsum Caso4.2H ₂ O As Primary mineral Calcite Caco3 and Quartz Sio2 as secondary Mineral	GypsumCaso4.2 H ₂ O As Primary mineral Calcite Caco3 and Quartz Sio2 as secondary Mineral	GyssumCaso4.2 H ₂ O As Primary mineral Calcite Caco3 and Quartz Sio2 as secondary Mineral

Chemical analysis

Three gypcrete soil samples were analyzed to determining major oxides in ALS Laboratory Group\Spain CERTIFICATE SV13090390. The Analytical Procedures showed below in Tablea3 and the analytical result showed in Tables 4and 5.

Table 3: Analytical procedures in Als, Spain

ANALYTICAL PROCEDURES		
Als code	Description	Instrument
ME-4ACDBI	Base Metals by 4-acid dig.	ICP-AES
ME-ICP06	Whole Rock Package-ICP-AES	
C-IR07	Total Carbon (Leco)	
SIR08	Total Sulphur(Leco)	
ME-MS81	Lithium Borate Fusion ICP-MS	
ME-MS42	Up to34 elements by ICP-MS	
OA-GRA05	Loss on Ignition at 1000C	
TOT-ICP06	Total Calculation for ICP06	

Table 4: Chemical analysis of gypcrete from Alexandria site 1 at depth A1, A2, A3 (ALS Laboratory group/Spain)

Sample No	Depth M	SiO ₂ %	Al ₂ O ₃ %	Fe ₂ O ₃ %	CaO %	MgO %	Na ₂ O %	K ₂ O %	TiO ₂ %	S %	L.O.I %	Bao %	C %
A1	0-0.50	10.3	1.71	0.59	28.4	0.67	0.32	0.22	0.08	15.4	19.54	0.01	0.23
A2	0.50-1	13.8	2.15	0.84	25.7	0.93	0.45	0.23	0.10	13.8	18.55	0.01	0.38
A3	1-1.5	33.4	5.77	2.13	20.8	1.71	1.39	0.72	0.32	6.52	16.00	0.2	0.171

Tables 5 : Chemical analyses of gypcrete from Alexandria at depth (A1,A2,A3) in ALs/spain

Sample Description	Method	WEI Recvd Wt. Ke	ME-ICPO6 SIO2 %	ME-ICPO6 AI2O3 %	ME-ICPO6 Fe2O3 %	ME-ICPO6 CaO %	ME-ICPO6 MgO %	ME-ICPO6 Na2O %	ME-ICPO6 K2O %	ME-ICPO6 Cr2O3 %	ME-ICPO6 TIO2 %	ME-ICPO6 MnO %	ME-ICPO6 P2OS %	ME-ICPO6 SrOS %	ME-ICPO6 BaO %	ME-ICPO7 C %
A1		0.02	10.30	1.71	0.59	28.4	0.67	0.32	0.22	0.01	0.08	0.01	0.02	0.49	0.01	0.23
A2		0.02	13.80	2.15	0.84	25.7	0.93	0.45	0.23	0.03	0.10	0.01	0.01	0.36	0.01	0.38
A3		0.02	33.4	5.77	2.13	20.8	1.47	1.39	0.72	0.05	0.32	0.05	0.06	0.12	0.02	0.17
Sample Description	Method	S-IROB	ME-MS81 Br	ME-MS81 Co	ME-MS81 Cr	ME-MS81 C2	ME-MS81 Dy	ME-MS81 Er	ME-MS81 Eu	ME-MS81 Ca	ME-MS81 Cd	ME-MS81 Ht	ME-MS81 Ho	ME-MS81 La	ME-MS81 Lu	ME-MS81 Nb
A1		15.40	44.4	4.8	80	0.55	0.38	0.19	0.12	2.1	0.43	0.5	0.08	2.7	0.03	1.5
A2		13.60	68.0	5.4	170	0.26	0.53	0.32	0.15	2.4	0.52	0.8	0.11	2.8	0.05	1.7
A3		6.52	158.0	15.7	390	0.56	1.46	0.88	0.43	5.5	1.58	1.3	0.31	5.0	0.13	3.9
Sample Description	Method	ME-MS81 Nd	ME-MS81 Pr	ME-MS81 Rb	ME-MS81 Sm	ME-MS81 Sn	ME-MS81 Sr	ME-MS81 Ta	ME-MS81 Tb	ME-MS81 Th	ME-MS81 Tl	ME-MS81 Tm	ME-MS81 U	ME-MS81 V	ME-MS81 W	ME-MS81 Y
A1		2.2	0.57	12.2	0.41	1	3690	0.3	0.06	0.74	<0.5	0.03	0.56	22	16	2.2
A2		2.5	0.67	7.5	0.51	<1	3040	0.1	0.06	0.87	<0.5	0.04	0.52	40	<1	30
A3		7.3	1.96	18.7	1.50	1	1000	0.3	0.24	2.05	<0.5	0.13	2.52	60	<1	8.4
Sample Description	Method	ME-MS81 Yb	ME-MS81 Zr	ME-MS81 As	ME-MS81 Bi	ME-MS81 Hg	ME-MS81 Sb	ME-MS81 Se	ME-MS81 Te	ME-MS81 LOI	ME-MS81 Total	ME-MS81 Ag	ME-MS81 Cd	ME-MS81 Co	ME-MS81 Cu	ME-MS81 U
A1		0.02	19	8.8	8.08	0.036	0.15	0.4	0.03	19.45	62.28	<0.5	<0.5	2	4	10
A2		0.30	31	5.2	0.02	<0.005	0.19	0.5	0.03	18.55	63.17	<0.5	<0.5	4	3	10
A3		0.80	47	4.5	0.03	0.006	0.18	0.5	0.03	16.00	52.55	<0.5	<0.5	8	7	10

Results and Discussion:

The (XRD) Fig (1,2 and 3) showed that samples at different depth contain gypsum which was identified as the main mineral in gypcrete followed by calcite and quartz as secondary minerals and showed the difference in mineral composition with depth because the mineralogical composition by XRD is not sensitive to concentrations less than 5% in the samples, also we realized that the identification of minerals depends on their crystallinity [3,7]. So this instrument couldn't be useful for complete mineral identification (figure 1, 2and3). Microscopic slide for the samples taken (depths 0-0.5m, 0.5-1m and 1-1.5 Table.1) showed that gypsum was the dominated material in all samples near earth surface with percentage 63% of soil content, this value number decreases with depth

increasing up to 1-1.5m until reaching 8.84% then comes calcite (carb-onate) concentration to be the second dominant and its concentration increases with depth[3] reaching 44% of soil content at 1.5m depth, then there is the Quartz which is 4.9% at the surface and increases to 13.2% at 1.5m depth [11]. All other elements are in between of the above in percentage with some variation, and in some become equal in their percentages in all depths this could be due to the fact that gypsum present in the area is of secondary origin, and has rivals been transported by the action of surface water then redeposit at different long time. This is why it is found concentrated near the surface decreasing within depth (0.5-1.5m). [11, 6]. In Table (4, 5) show representative samples taken from the surface down to 0.5m.

Silicon oxide is the less, increasing with depth (1-1.5m) up to 33.4%, this fact is repeated for Al, Fe, Na, Mg, K, Ti and C oxides, while Ca, Sr and S oxides decrease with depth as well as L.O.I, Ba oxides remains as it is. These results confirm the fact that gypsum is concentrated at and near surface, while soil increases with depth composed of Na, Si, Fe, Al, Mg..etc. Oxides [3]. Element analysis and their concentration vary within the depth (Table 5) showed that some of them increases with depth increasing except Hg, Bi, and As remain without change. Others showed no significant variations [9]. This could mean that samples at and near the surface were washed repetitively, this operation caused migration of most of the oxides to the lower parts of the soil, and also there is no ground water effect that can dissolve and carry them again up to the surface in order to re-precipitate them at the surface again.

Conclusions

1. The gypsiferous soil of Alexandria area is of secondary origin.
2. Precipitating environment is arid and semi-arid.
3. Ground water table are low in the region enabling some elements to be concentrated below the surface keeping them below 1m depth.
4. Washing process taking place at the surface (0-0.5m depth) is very slow and not active due to little annual season rain fall in the area.
5. Most of researches recommended to be done study mineralogical variation down to 5m depth reaching the ground water table.

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دراسة سطحية – تحت سطحية جيوكيميائية ومعدنية للجبريت في منطقة الاسكندرية وسط العراق

ونام حسن كاظم

قسم الكيمياء، كلية العلوم للبنات، جامعه بغداد، بغداد، العراق

الخلاصة:

تعرف التربة الجبسية بانها تربة هشّة تحتوي خليط من الجبس الثانوي ومن الطين والرمل وتوجد هذه الترسبات في المناطق السطحية وتحت السطحية التي تمتاز بقلّة الامطار اقل من 400 ملم وسرعة التبخر. يتضمن البحث دراسة الترب الجبسية في منطقة الاسكندرية في محافظة بابل ، وقد اظهرت الدراسة المعدنية الجيوكيميائية ان هذه الترب الجبسية تتكون بصورة رئيسية من الجبس الثانوي والكالسايت والكوارتز ومعادن طينية وانواع مختلفة من المعادن الثقيلة بكميات مختلفة. وقد استنتج بان سبب تركيز الجبس الثانوي في الطبقة السطحية هو ان المنطقة جافة قليلة الامطار بالرغم من الظروف المناخية الرطبة والدايفة في منطقة ذات التضاريس الواطئة لذلك يكون تأثير التجوية قليلة والسبب الثاني هو انخفاض مستوى المياه الجوفية لذلك يكون تأثير الخاصية الشعرية يكاد يكون معدوماً. وقد اظهرت الدراسة المعدنية البتروكرافية تأثير الكالسايت في العمق من 0.5م الى 1م ثم الكوارتز من 1م الى 1.5م.

الكلمات المفتاحية: جبريت، تربة جبسية، العمق، التأثير البيئي للغسل بواسطة الامطار والمياه الجوفية.