Sci. J. Fac. Sci. Menoufia Univ. Vol. VIII (1994) 125-134

THE RECENT ROCK FALLS AT EL'MOKKATAM CITY; "IS IT AN ENVIRONMENTAL GEOLOGICAL PROBLEM"?

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ABSTRACT

Fourty years ago, El Mokkatam City had built on El Mokkatam plateau directly east of Cairo. It is appeared that the City planning neglect seewage network. Seewage water entering the City foundation bedrock, which consists mainly of fractured limestone over thin shale layers, becomes subsurface water, penetrating the natural fissures and causing landslides at the plateau boarder. Accordingly, the road construction and touristic activities seriously suffered from damage. Field study as well as hydrogeochemical analysis of the subsurface water seepage have done. Creation of seewage network in the city as well as stopping construction and relocate the road away from the boardering unstable area are recommended.

INTRODUCTION

The purpose of this article is to demonstrate the severe response of a desert landscape to an artificial hydrological change. Accelerated rock falls of El Mokkatam desert cliff due to uncontrolled seewage water disposal was investigated. The introduction of this new hydrological factor resulted in a severe disturbance of the morphological balance in the vicinity of the cliff. Seepage is probably the most common problem related to Engineering geology (Ibrahim, 1989). Excessive amounts of water are generally accepted as being the major cause of instability in wet regions. However, the lack of water in an arid region tends to relegate this factor to a minor role in planning and design. Consequently, the long term effect of introduced water is often given sufficient consideration. The present case is an example of rock falls developed and accelerated due to the disposal of seewage waters.

The harmful effect of uncontrolled seewage water on the foundation bedrock has been reported in several areas of the arid rogions.

Climate

The climate of the area is arid (Meigs, 1953). According to the Egyptian Meteorological Authority Report (for ten years from 1978 to 1987); the average annual preoipitation is just 15 mm. The rainy season is during the winter. The average annual relative humidity is about 56%. On the other hand, the average annual evaporation 10mm. with daily temperatures ranging from 16-28°C.

Geologic Setting:

El Mokkatam cliffs are rising to about 240m. The Mokkatam rocks exposed in this area can be classified into two units (Said, 1962):

a.Maadi Formation: It consists the upper parts of the cliffs and belong to Upper Eocene age.

According to El Said (1984); the major minerals occuring ar calcite, dolomite and Quartz. Calcite ranges from 40 to 89% with an average of 69%. Dolomite ranges from 10 to 93% with an average of 53%. Also, Quartz ranges from 2 to 48% with an average of 14%. Maadi Formation microfacies is dominated with biomicrite limestone varities which show recrystallization of biomicrosparite.

b. El Mokkatam Formation: It consists the lower parts of the cliffs and belong to Middle Eocene age. It is forming mainly from calcite mineral which ranges from 84 to 95. Also the Quartz mineral presented in considerable quantities (i.e. reaches up to 10%). El Mokkatam formation is dominated with bicomicrite limestones.

The cliffs are mainly composed of compact limestones in the lower parts which beome dolomitic in the upper parts.

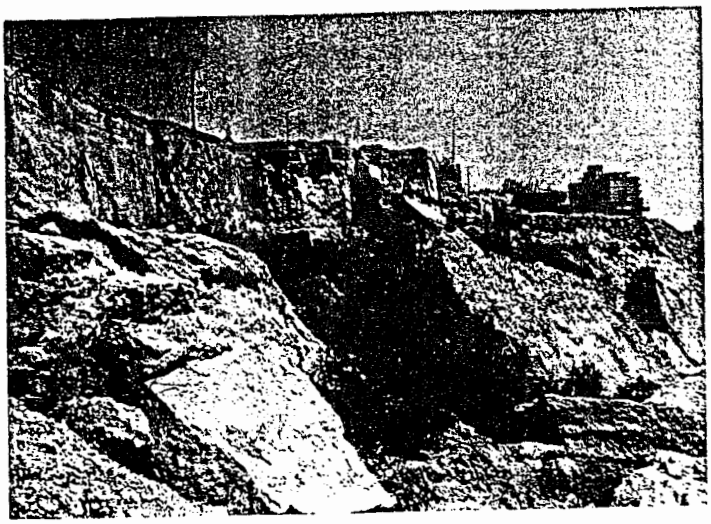
Field observations:

The Mokkatam City drained its anthropogenic wastes through soakhalls. This water seeped through the discontinuites (i.e. joints, faults, and fractures) which spreading in the city foundation limestone bedrock. There are several shale stricks interbeded within this fractured

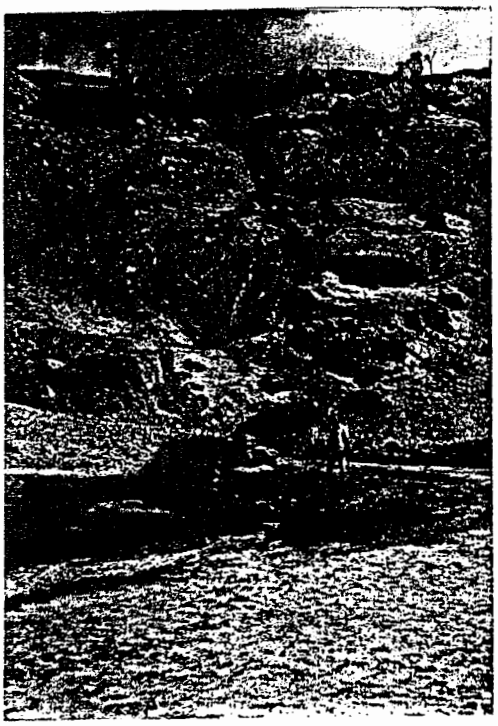
limestone blocks slide over this swelling clay flakes (Figure, 1). Landslide is defined simply as a relatively rapid downward and outward movement of earth materials (Hayes, 1971). This hypothesis may be supported by the presence of flourished vegetation which spread on the nearly vertical well-Fractured limestone cliff facing Cairo. These flourished vegetation feed by organic matter rich-subsurface water seepage which comingout through the fissured cliff. The drained subsurface water seepage detected in several locations which either forming small pools at the topmost part of the cliff or running downslope. Salt efflorescence, salt crystals and dark brown puffy surfaces are observed on the seepage drainage areas (Figure, 2). The recent landslides at the boardering unstable area cause severe damage to the asphaltic road as well as the adjacent builings and several touristic constructions which built at the boarder unstable area. Some parts of the road are completel falled down, other inward parts have potentially landslide. The traffic was banned in the damaged parts. The foundation bedrock for a considerable part under the modern hotel, falled down; accordingly the hotel closed down because its dangereous situation. Also, parts from the boarder clubs buildings either fractured or broke down.

Clay Stricks:

Special interest has been paid to the presence of the clay stricks within the limestone beds forming the cliffs. The clay stricks are very thin parallel horizontal layers ranging from 10 to 15 cm. in thickness dark brown in colour.



(Figure 2) : Rock falls, Relics of the Asphaltic Road appeared clearly. The fluorished vegetation appeared as well.



(Figure 1) : Seepage water running downslope. Salt efflorescence and dark brown puffy surfaces are appeared clearly.

Several clay stricks are detected in the study cliffs, few meters apart from each other. The nearest clay strick is about 6m. from the topmost bed of the cliffs (where the falling road was existed).

Three samples from the clay stricks were subjected to the free swelling test (using the increase in volume to initial volume method; permanent committee for preparing New Code, 1990).

The results show the clay stricks have swelling characteristics ranging from 40 to 65% as free swelling.

Results and discussion of hydrogeochemical analysis:

Hydrogeochemical analysis of extracted solutions of samples collected from seepage drainage lines, as well as samples from the pools founded at the top most part of the cliff was done. The results show (Table, 1) that high salinity water with total dissolved salts ranging from 4003-31820 ppm was detected. Its salinity is more or less equivalent, if not exceed that of the seewage water (El-Nemr and Ibrahim, 1991). Also, Sodium is the dominant cation while chloride is the dominant anion. On the other hand, chloride salts are the dominant hypothetical soluble salts followed by bicarbonates and sulphates (Table, 2)

The Mechanism of Rock falls:

From the field observations, hydrochemical analysis of the subsurface water, and geotechnical properties of the clay stricks; it may be attribute the acceleratin recession of the Mokkatam desert cliffs to environmental geological aspects. Uncontrolled domestic water (drinking water, seewage water, and irrigation gardens residuals)

Table (1) : Concentrations of major ions (as m.eq. / L.) of seepage water from the recent rock falls area, El-Mokkatan City.

Sample Type	T.D.S.	Cations				Anions			
	P.P.M.	Na	K	Mg	Ca	Cl	SO_4	CO_3	HCO_3
1. Seepage Water	7589	1719.0	625.00	48.0	512.0	3124	1344.0	-	216.50
	m.eq./L.	75.0	16.00	2.0	12.8	88	14.0	-	3.55
2. Seepage Water	31820	10000.0	400.00	86.0	272.0	9940	1152.0	-	9970.00
	m.eq./L.	435.0	10.30	3.6	6.8	280	12.0	-	163.00
3. Seepage Water	5332	750.0	500.00	19.2	512.0	710	1267.0	-	1573.80
	m.eq./L.	32.6	12.80	0.8	12.8	20	13.2	-	25.80
4. Seepage Water	4003	600.0	400.00	19.2	416.0	852	768.0	-	948.50
	m.eq./L.	26.1	10.25	0.8	10.4	24	8.0	-	15.55
5. Pool	2163	200.0	200.00	9.6	320.0	284	768.0	-	381.00
	m.eq./L.	8.7	5.15	0.4	8.0	2	8.0	-	6.25
6. Pool	6105	1700	200.00	96	112.0	2130	806.0	-	1060.00
	m.eq./L.	73.9	5.10	4.0	2.8	60	8.4	-	17.40

Table (2) : Hypothetical soluble salts in seepage water from the recent rock falls area, El-Mokkatam City

Sample Type	KCl	NaCl	Na_2SO_4	$MgSO_4$	Ca_2SO_4	$CaHCO_3$	$NaHCO_3$	$MgHCO_3$
1. Seepage water	13.3	60.3	1.7	3.3	18.4	2.9	-	-
2. Seepage water	2.2	57.7	5.1	-	-	2.9	30.2	1.5
3. Seepage water	17.6	10.1	34.2	1.8	-	35.3	-	0.4
4. Seepage water	29.5	1.3	36.6	2.3	10.4	19.9	-	-
5. Pool	16.7	9.8	18.6	2.6	31.7	20.5	-	-
6. Pool	5.5	58.2	17.8	-	-	6.0	3.8	8.6

infiltrated through the well fractured dolomitic limestones (two set of closely spaced joints). It seepage downward untill reaching the clay sticks. The clay stricks become swalled after wetting by domestic water and behave plastically such as lubricating oil. In such case, the clay stricks are formin the main sliding surface. It appears that the huge compact limestone blocks separated from the mother cliffs along the fractures surfaces and sliding at the contact between the limestones and the swelled clay underneath.

In spite of the foundation bedrock of El Mokkatam city composed from hard compacted dolomitic limestones; it's fractures system as well as the clay stricks within it played, serious role in its falling at the borders in the presence of uncontrolled domestic water.

CONCLUSION

The present study points out the importance of taking into consideration the mechanical and lithological factors of the material founding the cliffs and the influence of the change in them by infiltration water.

The lack of seewage network in El Mokkatam City may be the cause of recent rock falls. The presence of well-fractured limestone (i.e. closely spaced joints), salty subsurface water which gathered in pools at the topmost part of the cliff as well as drained downslopes, clay stricks, and fluorished vegetation at the recent rockfalls area may support this hypothesis. Stopping any leakage of domestic water as possible to Mokkatam foundation bedrock is likely to be the solution.

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الانهيارات الجبلية الحديثة بمدينة المقطم
هل هى مشكله جيولوجيه بيئيه؟

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منذ أربعين عاما مضت ، تم إنشاء مدينة المقطم فوق هضبة المقطم شرق القاهرة مباشره.. وعلى مايبدو أن مخططى المدينة لم يضعوا فى اعتبارهم انشاء شبكه للصرف الصحى بها. وقد تسبب تسريب مياه المجارى إلى اسفل فى طبقة التأسيس (والتى تتكون اساسا من حجر جيرى به شقوق تتخل طبقات رقيقه جدا من الطفلة) فى الانهيارات الجبليه عند الحافة

وقد اتضح من الدراسات الحقلية والجيوهيدروكيميائية إلى أن الحل الامثل لوقف الانهيارات الجبلية هو انشاء شبكه للصرف الصحى بالمدينه ووقف اعمال البناء على حافه الهضبة المعرضة للإنهيار وكذلك اعاده انشاء الطريق الاسفلى بعيدا عنها.