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By: Kamal Haji Karim Ahmad *
Ghafor Ameen Hamasur *
Sherzad Tofiq Mohamad *

* Department of Geology, College of Science,
University of Sulaimani

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Part A
College of Medicine / Third Floor
University of Sulaimani
Sulaimani
Kurdistan Region
Iraq
E-Maile: Szanco@aol.Com
Fax: 00 44 87 012 70 903, 00 44 87 016 96 314

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ABSTRACT

This paper deals with a rock failure from Pira–Magroon Mountain, Northeastern Iraq. Field study and graphical representation showed that this failure is a rockslide. Being located near Qara-Chattan village, we named this phenomenon as Qara-Chattan Rockslide. About 200 million tons of rock materials are slided from the elevation of 2900 meters above sea level to the elevation of 1000 meters. The slide rock debris now rested on a gently sloping plain near the village and forming a tongue like hill about 50 meters high. Many geomorphologic features and slide activating factors are also discussed as well as stereonet analysis of the rockslide.

INTRODUCTION

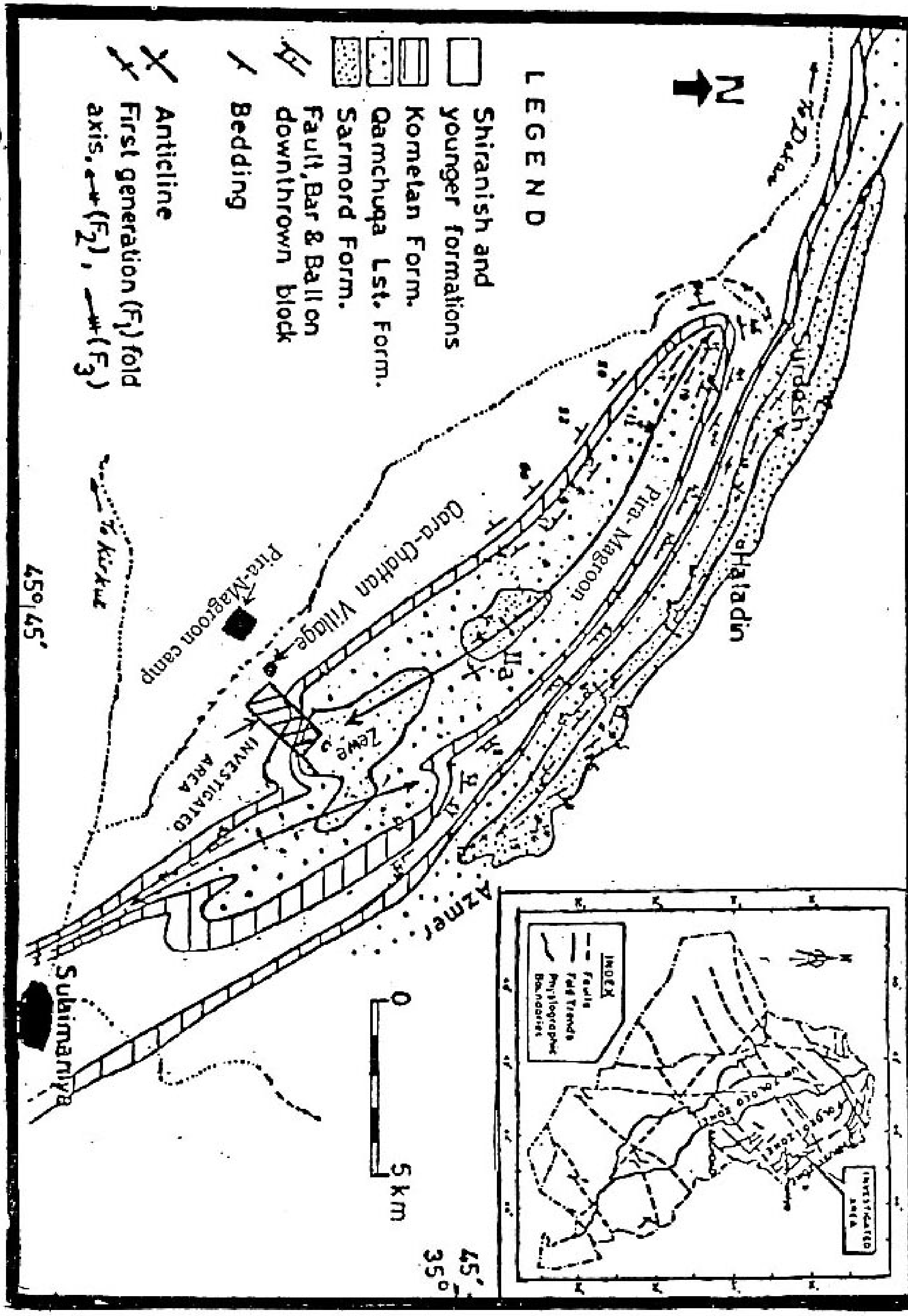
Landslides including rockslides have been given greatly increased attention because of the increase in magnitude and frequency of landslide problems, especially when large cuts and fills are made for dams, highways, foundations and other engineering projects. Each year many lives are lost by natural and man-made landslides and caused many major catastrophes, which wiped out villages occasionally.

This rockslide is located immediately to the northeast of Qara-Chattan village, and about 25 kms to northwest of Sulaimani city which can be seen clearly from the main paved road connecting Sulaimani and Dokan city. The slide is occurred along the steep slope of southwestern side of Pira-Magroon Mountain. Structurally, it represents a double plunging asymmetrical anticline, fig. (1).

This rockslide is the largest slope failure recorded in northern Iraq. This study is very important to investigate the factors caused the Qara-Chattan rockslide, especially there are many cities, road, villages and dams located between high mountains which may slide at any time.

EVIDENCES FROM FIELD WORKS

The studied area and it's surroundings are geologically surveyed for mapping, measurements and recording all geological phenomena related to Qara-Chattan rockslide. Full description of the features such as, slide rock debris, slide scar and U-shaped valley were also made



Fiig(1) Geological map of Pira Magroon anticline(Al-Fadhli et al, 1979)(2).

1. Slide rock debris

It is composed of recrystallized gray to brown dolomitic limestone, which belongs to Qamchuqa Formation (Middle Cretaceous) (Bellen et. al, 1959) (1). This Formation form a carapace of Pira-Magroon mountain from which the rock debris detached and moved down slope from the upper part of the mountain slope, near its crest and rested on gently sloping plain, near Qara-Chattan village. There the slided rocks debris form a relatively large elongated tongue-like hill, plate (1.1) and (2.1). It is about 50m high and its mass estimated to be about (200) million tons (Hamasur, 1999)(3). The direction of elongation is along the slope, from the slope toe toward Qara-Chattan village fig. (2).

The hill is composed of massive angular blocks and clasts of various sizes showing breakage and some brecciation. According to (Dennis, 1987)(4) the sliding slabs are transported rapidly and usually disintegrate down slope during movement and finally come to rest as jumbled and brecciated mass. The hill material, being contain blocks weighted about sixty tons, can be easily distinguished from the surrounding soil, fig. (2) and plate (1.2).

The blocks and clasts are generally; matrix free and self- supported, except for some recent red soil filling the cavities between the blocks and clasts, plate (4.3). The slide masses occupy an area about two square kilometers, which has irregular, rough, rocky surface in contrast to planar and featureless surrounding area.

2. Slide scar surface

This represents the original place of slide rock debris and part of the surface on which the sliding occurred. It is parallel to bedding surface and located on the southwestern side of Pira-Magroon Mountain at an elevation of 2900 meters above sea level near the crest of the mountain. The field study is showed that the scar surface coincides with the upper boundary of the Sarmord Formation (Lower Cretaceous). This means that the sliding is occurred on this formation. It is composed of green marl and marly limestone plate (2.2) and fig. (2& 3). The slide scar is relatively smooth and planar at its upper part while concave and covered by lagged rock blocks at the lower part, plate (3.2) and (3.3).

3. U- shape valley

A steep-sided valley is formed by Qara-Chattan rockslide. Its upper part is coincided with the slide scar and the lower one with upper part of sliding surface,, plate (1.1) and. (1.2). The valley locally called Qulla-Rash valley, which developed at expense of small former valley, existed in the same place. It is U-shaped, especially at its lower part. It formed by breaking former valley sides by the accelerated sliding rock masses when strikes them during down slope movement.

Factors effecting the qara- chattan rockslide

During the fieldwork many evidences were observed which they acted collectively to promote the failure of the rocky slope and then sliding down slope, plate (1.1) and fig. (2). Samples were also collected.

1-Geomorphological factors

The main geomorphological factors are the slope height and slope angle of the failure before sliding. What concerned the former is the height of the slope which is more than (1900) meters above the surrounding plain on which the slided rock debris now rested, fig. (3). The amount of the slope angle is about 50 degrees. The relation between these two factors is reversible with slope stability (Bell, 1980)(5) and (Hoek and Bray, 1981) (6). This means that whenever the slope angle exceeds (45) degrees, the slope height is high and the slope is unstable. Moreover, these two factors are of prime important in increasing shearing stress, which caused failure, and sliding of the rocky materials down the slope to reach the present place, which is about 3.5 kms far from the original place. The slope angle and slope height of the area, before sliding, was determined from both sides (shoulders) of Qulla-Rash valley.

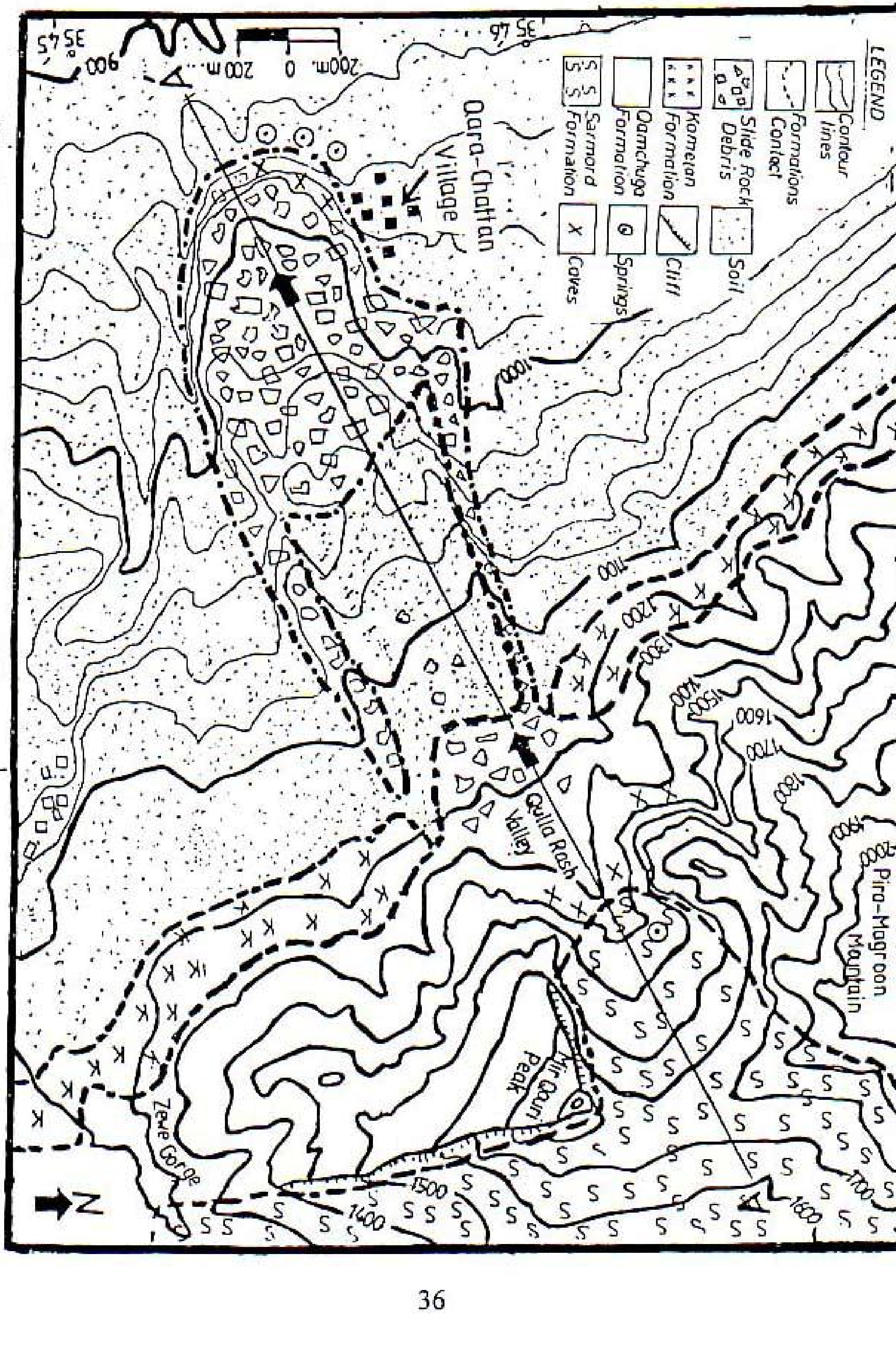
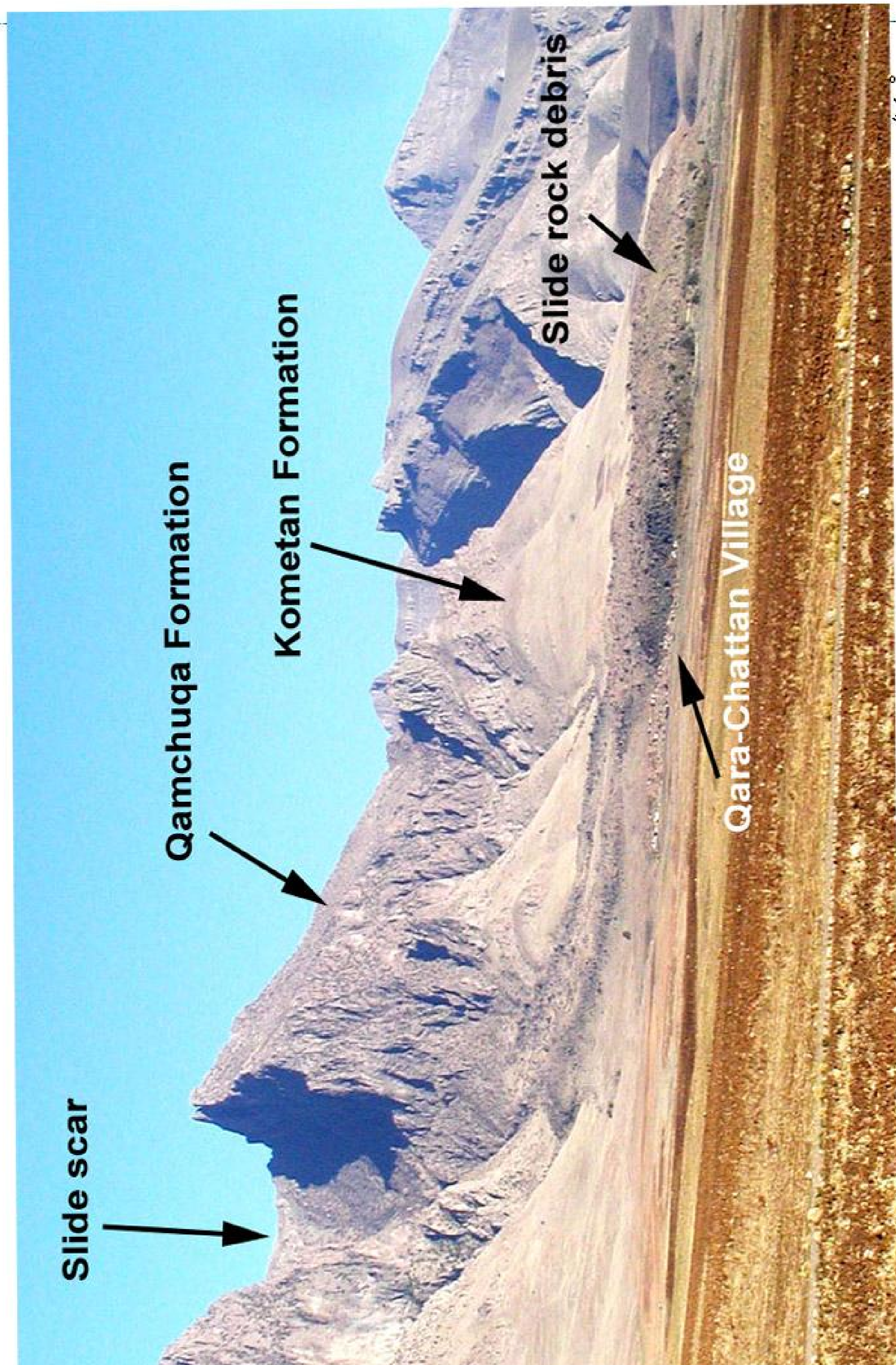


Fig.(2)Geological map of Qara-Chattan rockslide


Slide scar
Qamchuqa Formation
Kometan Formation
Slide rock debris
Qara-Chattan Village

2. Stratigraphical and lithological factors

Stratigraphical succession and lithology played significant role in creating convenient conditions to promote Qara-Chattan rockslide. Two Formations are in close relation to the slide. The first one is Qamchuqa Formation, which form the weathering resistance outer cover of Pira-Magroon Mountain. This Formation is composed of massive, recrystallized dolomitic limestone with thickness of about 500 meters. The second one is Sarmord Formation which underlying the first one.

Dolomite crystals and recrystallization can be seen clearly in thin section on broken surfaces of the first one, forming coarse grain texture, which contain esse-ntial porosity. Also there is a paleokarst zone between Sarmord and Qamchuqa formation. These two reasons facilitated infiltration of water through the later formation and consequently increase bulk density and then decrease shear strength.

The second one(Sarmord Fn.) is composed of fissile soft green marl. This formation representes a good sliding surface (its upper part) in addition to good impermeable surface, which permit the ground water only to circulate in overlying Qamchuqa Formation. The groundwater increases internal weathering and pore pressure (Blyth and de Freitas,1974)(7). According to the field observations the sliding occurred on two types of surfaces, on the green marl of Sarmord Formation at the upper part of the slope and on the soil surface at its lower part,fig.(2&3). Therefore the initial sliding can be classified as plane sliding, fig. (4).

3. Hydrological factors

Many important and interesting features were observed in the field, which are related to the influence of groundwater and causes decreasing of slope stability. These features are:

A. Solution caves belt

Many caves are observed in the studied area, they exist as a belt near the slope toe. This belt is located along the 1300 meter contour line, fig. (2) and plate (1.3). This represents former intersection line of the groundwater level with the slope surface. These caves are oval in shape and bounded by smooth internal surface, with many circular holes, which represent spring mouths. The groundwater is caused enlargement of the caves and followed by the failure of the slope. Moreover the cave floor covered by a layer of brown to earthy coarse calcite about 10cm thick. (This represents travertine deposit during seepage of groundwater plate (4.1). Railsback,et al., 1994)(8) are found calcite and partially dissolved aragonite layers in the caves of Late Holocene from Botswana .They returned aragonite layers to deposition in arid and high Mg/Ca environment The final effects of these caves are removal of slope supports (butters).

B. Friable dolomitic limestone

Another trace of groundwater effects in the cave belt is existence of friable coarse grain dolomitic limestone. Microscopic examination of the dolomite crystal showed that these crystals are clearly surrounded by fine matrix and porosity. This can be related to the action of percolating groundwater in Qamchuqa Formation, which dissolved calcite crystal more faster than dolomite ones forming essential porosity and decreasing stability of the pre-slide slope of Qamchuqa Formation and finally activating failure of the slope.

C. Ice mold caves

Many large caves are observed near Qara-Chattan village in the frontal part of slide rock debris, plate (4.2) and fig.(2).They are directly related to hydrological factor because they are interpreted as a mold of accumulated ice, brought down by slide rock debris. A part of which entrapped and covered by rock materials in the frontal part of the rock debris and then forming the caves after thawing. We called them ice mold caves, fig. (3).

Accordingly, the failure is occurred when thick layer of snow covered the slope and exerted additional weight on the buttresses of the slope with considerable hydrodynamic pressure, if part of the snow had been thawed at that time.

4. Structural factors

It has been found that the slope stability was directly affected by structural factors, these are:

A. Joints

The dolomitic limestone of Qamchuqa Formation is highly jointed due to the intensity of Albian Orogeny. This is reflected by two master joints, extending tens of meters. These sets are hko type, dipping at angles of (70 and 80) degrees in the direction of (110 and 334) respectively, and fig. (4). They formed two major cliffs plate (3.3). These joints might be played a great role in the sliding by separation the masses laterally. They are of conjugate hko- system (Turner and Weiss, 1963)(9).

B. Bedding plane

The dip of the bedding plane in the area, including the slided beds, is (41)degrees in the direction of (228) which coincides with the direction of sliding . The dip amount is less than the toe slope angle. This is returned to weathering processes at the slope toe, which cause daylighting of strata and consequently help failure (Hoek,1971a)(10). According to (Hamasur, 1991)(11) serious rocksliding will occur when the strike of discontinuities is parallel to the slope trend and when the dip is in the direction of the slope provided that it's amount is less than the slope angle. In this study this fact is illustrated by stereonet representation, fig. (4).

C. faults

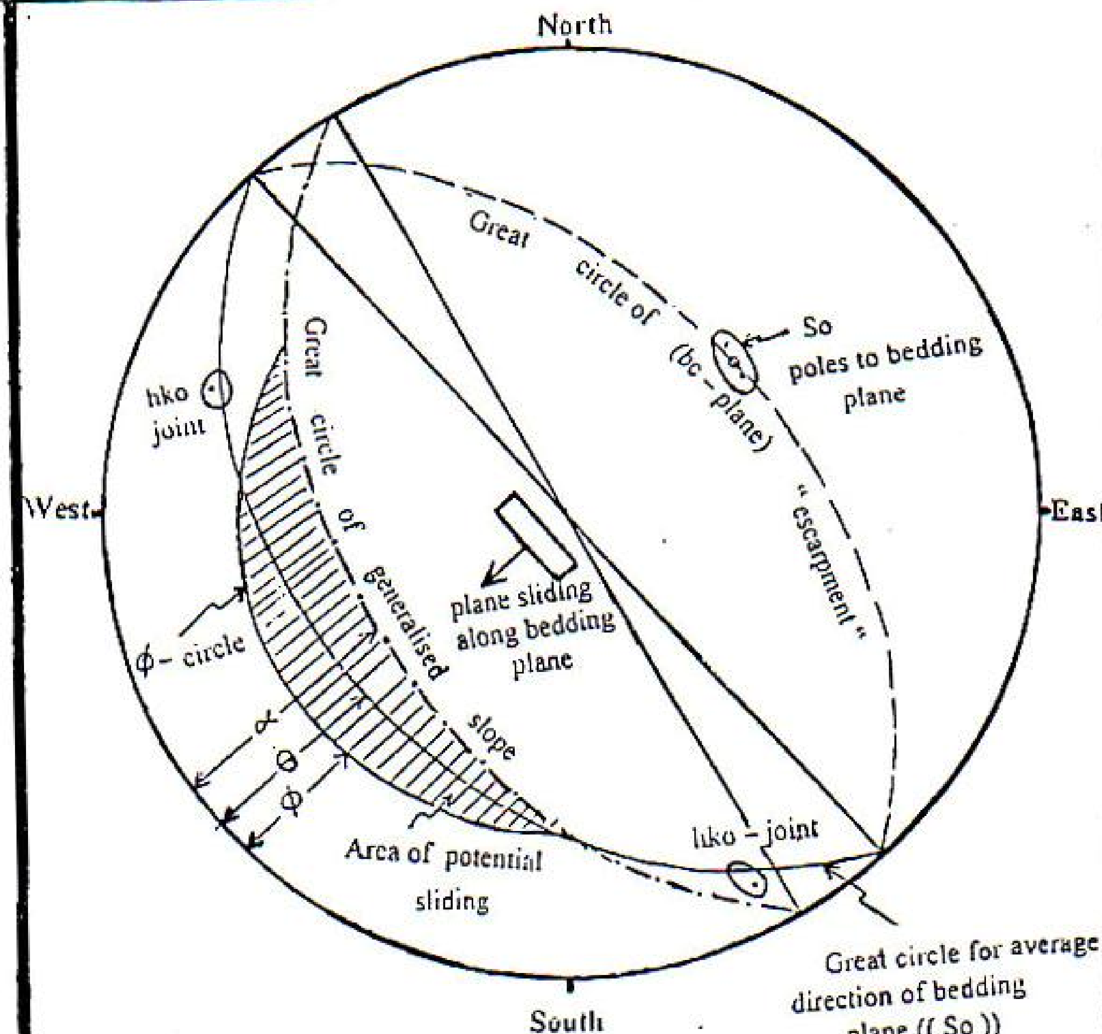
One fault is found in the area which is located in the crest of Pira-Magroon mountain with dip of (80) degrees in the direction of 232, plate (2.3).This fault has direct effect in activating the sliding in the two ways. The first one is the rock masses detached easily from the main body of the mountain, and the second one is that the fault acted as natural avenue which permits groundwater to flow in the direction of solution caves . The age relation between the fault and the rock slide is that the former one is older than the later which now form cliff at the back side of the valley, fig. (2).

STRUCTURAL CONCLUSION BY STEREONET

The attitude of the joints and the beds which exist in the area are graphically represented on the stereonet to show their relations with that of the slope. The slope is inclined (50) degrees in the direction of (240) and the average dip of strata is (41) degrees in the direction of (228), fig. (4) . The slope is parallel type depending on the divergence angle between slopes trend and the strata strikes. But according to a person whose face is toward the slope, it is left emergent slope type because the strike of the bedding appear to the left of the person. This type of slope also called concordant slope because the slope and strata are dipping in the same direction, fig.(3).The same principles were mentioned by (Al-Saadi,1981(1) as a slope classification.

The sliding surface,as upper part of Sarmord Formation, is composed of soft green marl.this lithology has certain internal friction angle which is about (30) degrees (Hoek and Bray,1981)(6). The stereographic projection revealed that:

1- The angle of strata ($\theta = 41$), is less than the slope toe angle (50) degree and more than internal friction angle of green marel ($\phi = 30$).
2- The great circle of strata is located in the area of potential sliding. As mentioned later the plane sliding occurred on the green marl in the same dip direction (228) of the strata. This happened when the cohesion became zero on the discontnuities surfaces. During the sliding, the bedding plane was represented as a sliding surface and conjugate (hko-system) as lateral release surface.



$\odot$ = Pole to joint

α = Slope angle

θ = Angle of internal friction

ϕ = Angle of bedding plane

Fig.(4) : Stereographic projection illustrating the relationships between discontinuities, Slope and type of failure at (Piramagroon – Qara Chattan) area.

Plate (1)

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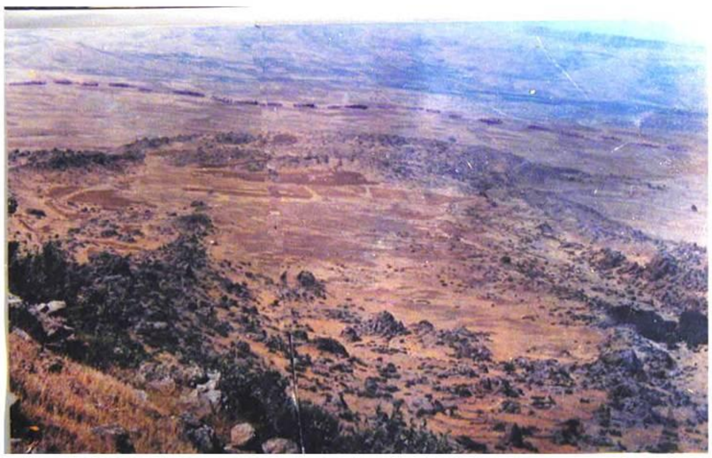

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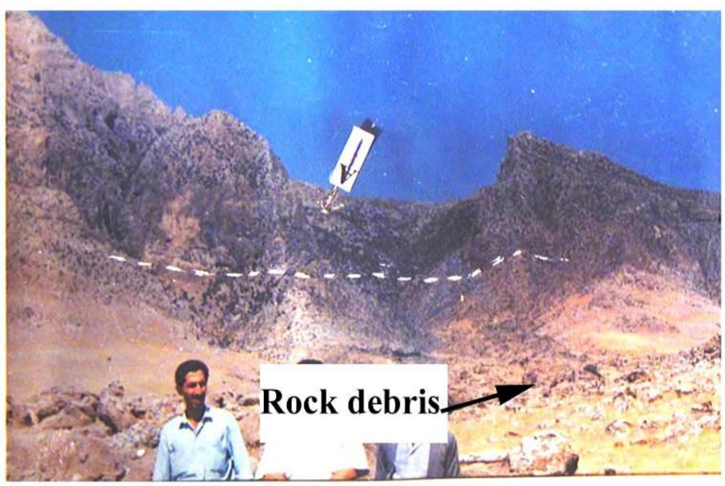

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plate (2)

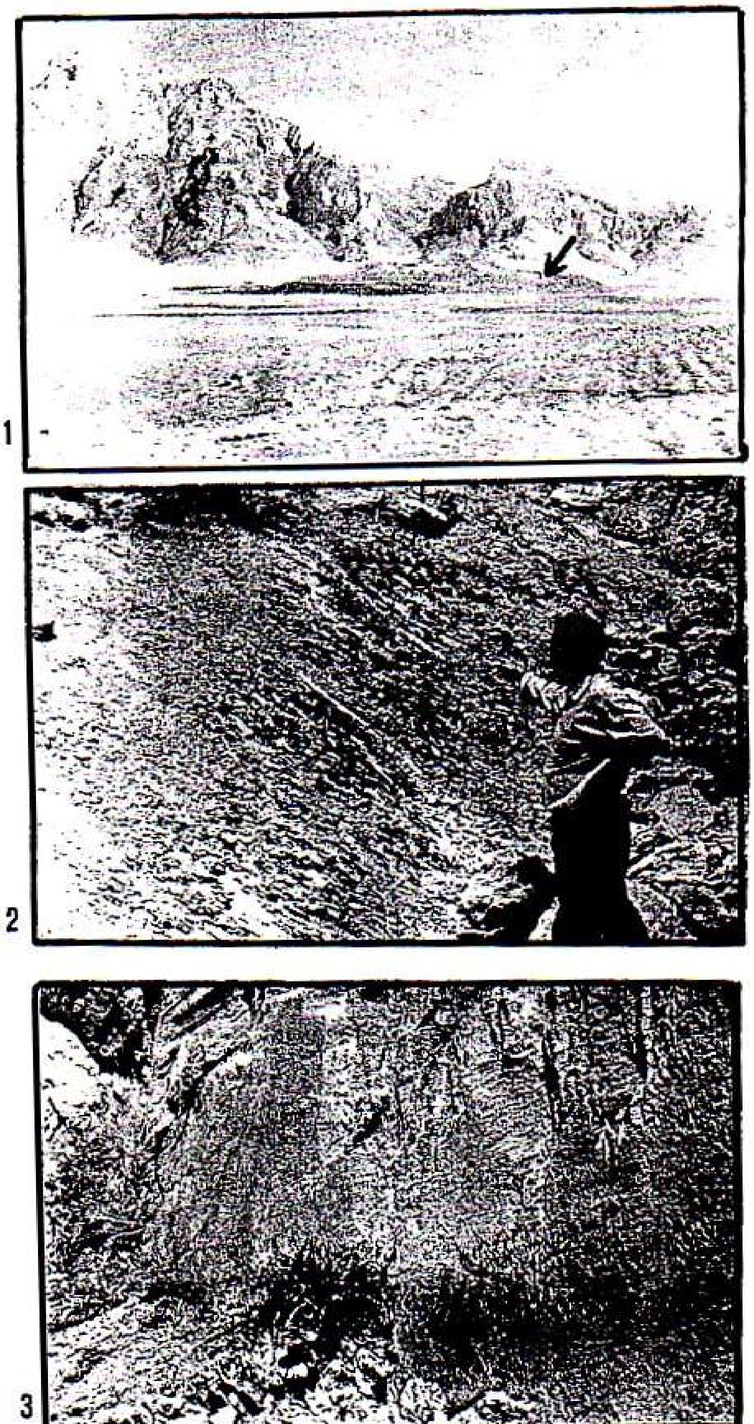

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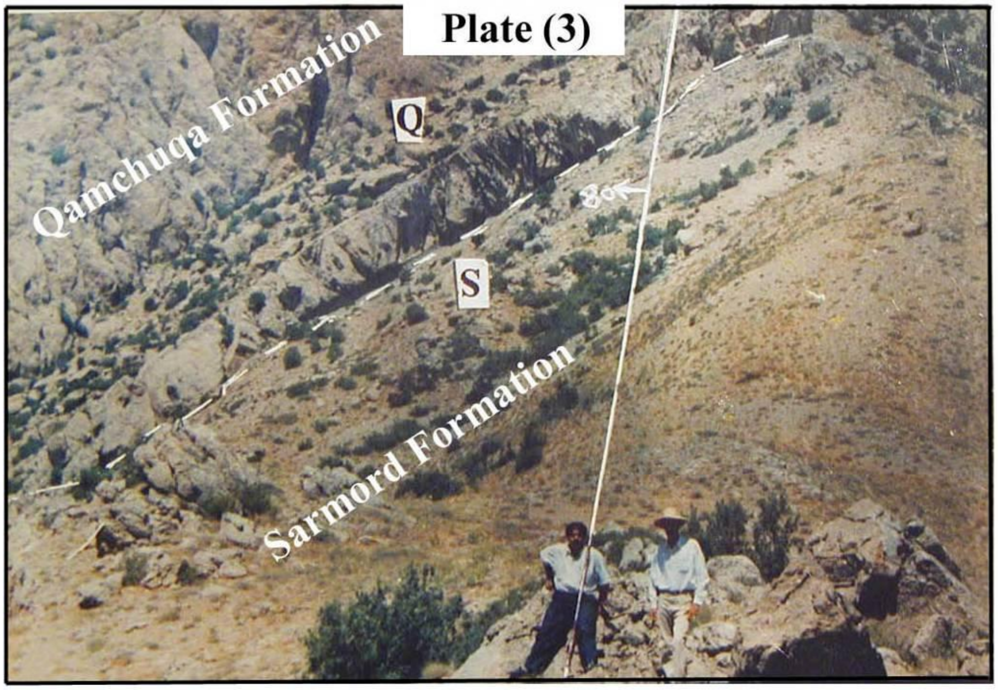
Plate (3)



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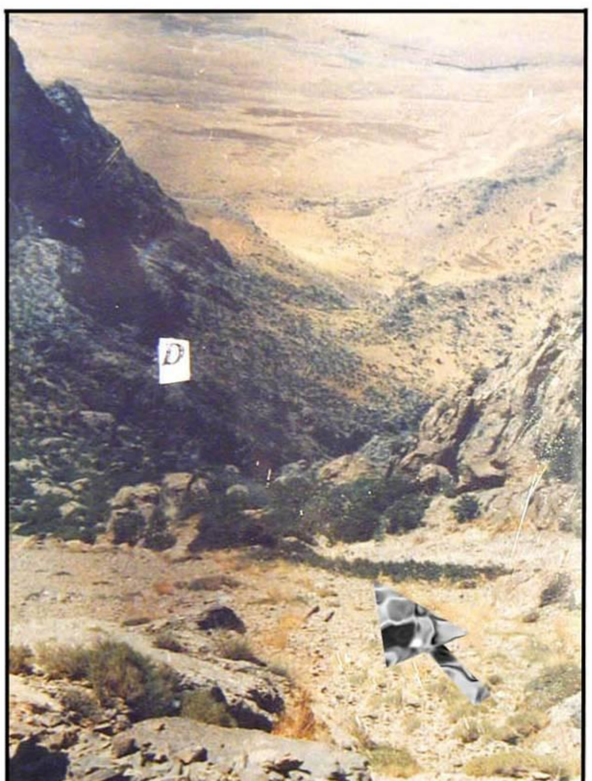

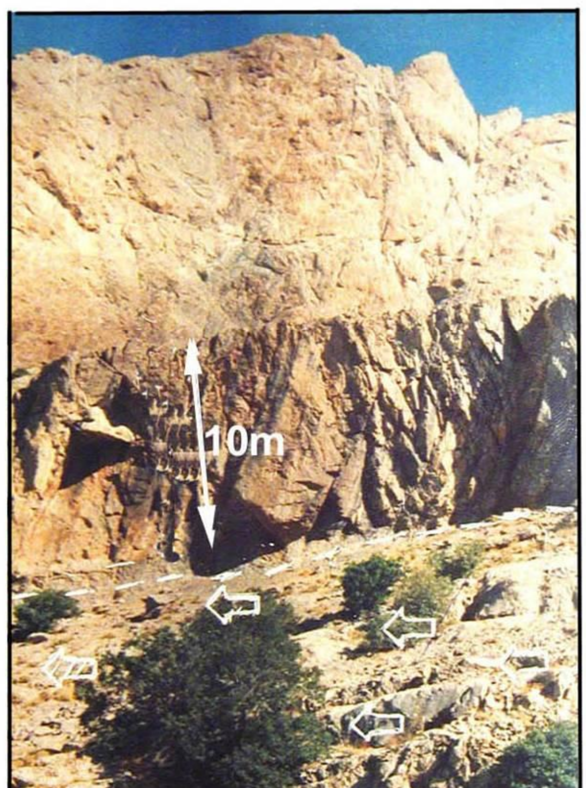

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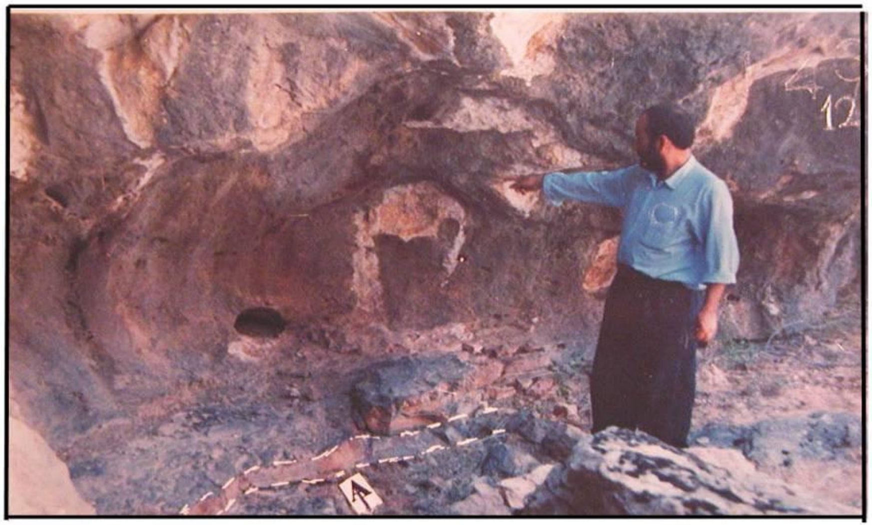
Plate (4)



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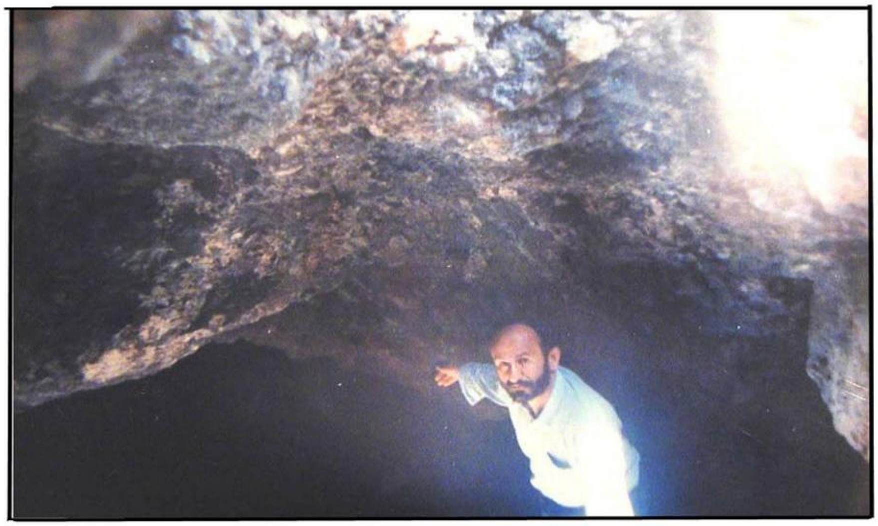

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CONCLUSIONS

This study led to the following conclusions:

1- The rockslide is named Qara-Chattan rockslide by which about (200) million tons of rock materials moved from their original place 2900 meters above sea level, to the elevation of 1000 meters. There it forms a tongue like hill about 50 meters high and with about (2) square kilometers in surface area.
2- The sliding is classified as plane sliding because massive dolomitic limestone of Qamchuqa Formation slided parallel and on upper part of Sarmord Formation.
3- The high values of slope height and slope angle are the most important geomorphological factors. The occurrence of massive thick beds of limestone over soft fissile green marl forms favorable condition for sliding.
4- The removal of the supports (strata) at the slope toe are returned to dissolution by groundwater where the former groundwater level intersected existed slope. These showed by caves and friable dolomitic limestone.
5- The sliding is occurred during accumulation of relatively thick layer of snow. The only evidence for this is the caves found at frontal part of the slide rock debris, which we called them ice mold caves.
6- The relation of many structural factors, such as conjugate hko-system, bedding plane and longitudinal reverse fault with slope geometry, forms a favorable condition for sliding.

PHOTOGRAPHES DESCRIPTION

plate (1)

(1.1) general view of the Qara-Chattan rockslide as photographed from Pira-Magrron mountain crest. This photo shows Qulla-Rash valley and its U-shaped segment with the slide rock debris and sliding surface at the background. Q=Qamchuqa Formation, S=Sarmord Formation. The arrow indicates location of Qara-Chattan village and frontal part of slide rock debris.

(1.2) close view of the lower part of sliding surface and rear part of sliding rock debris with some lagged blocks. The dashed lines represent the paved road between Sulaimani and Dokan city.

(1.3) Qulla-Rash valley as seen from the surface of slide rock debris. The dashed line indicate where solution caves and friable dolomitic limestone exist. The arrow indicates upper part of slide scar.

plate (2)

(2.1) lateral view of the Qara-Chattan rockslide as seen from the paved main road between Siulaimani and Dokan city. The arrow indicates where the ice mold cave exist in the frontal part of slide rock debris.

(2.2) Fissile green marl of Sarmord Formation as exposed in the valley which represents both, slide scar and sliding surface.

(2.3) The fault surface, dips (80) degree in the direction of s52w which locate near the mountain crest.(The showed surface is1.5 m. wide)

plate (3)

(3.1) The upper part of left side of Qulla-Rash valley, shows the contact (dashed line) between Sarmord Formation (S) and Qamchuqa Formation (Q) on the crest of the anticline, the white line shows the position of the fault.

(3.2) The left part of the valley shows relatively smooth surfaee on which sliding occurred (sliding surface) as showed by an arrow. The letter (D) indicates location of daylighting strata.

(3.3) Close photo of left shoulder (side of the valley) shows relatively fresh outcrop(slide scar) of both formation from which part of rock masses detached and slided in the direction shown by arrows. This photo is taken from the (S) position in the plate (3.1).

plate (4)

(4.1) solution caves with relatively smooth internal surface, the circular hole represents spring mouth before sliding. The arrow indicated (10) cm thick travertine layer at the floor of the cave.

(4.2) Ice mold cave at the frontal part of slide rock debris.

(4.3) The slide rock debris near the above cave which composed of boulder and pebble sized clasts.

REFERENCES

1. Bellen, R. C. Van, Dannigton, H. V., and Morton, D. M., Lexique Stratigraphic international, vol. 3, Asie, Paris, Interant, Geo. Cong. Comm.Stratig.,Pt, 1959,10a, p 333.

2. Al-Fadhil, I., Janardan Rao, Y., Oweiss, G. and Khalil, M., Polyphase deformation in a part of Zagros, Sulaimanyi District, NE. Iraq; J. Indian. Academy of Geoscience, 1979. **22**,1-31.

3. Hamasur,G.A., The Quantitative Analysis of the Qara-Chattan Rock-Slide from Northeastern Iraq.The First Scientific Conference of Dohuk Unversity.J.Dohuk University,1999,**2**, 465-476.

4. Dennis,J.G.,Sructural Geology:An Introduction.Wm.C. Brown publishers. USA.1987, p 448.

5. Bell, F.G., Engineering Geology and Gotechnics. Newnes-Butter worth, London. 1980

6. Hoek, E, and Bray, J. W., Rock Slope Engineering (3rd. ed.), Institution of Mining and Metallurgy, London, 1981, p 358.

7. Blyth, F.G.H. and de Freitas,M.H., A Geology for Engineers (6th ed.). Edward Arnold, London,557Pramanik. 1974

8. Railsback,L.B., Brook,G.A., Chen, J., Kalin, R. and Fleisher, C., Environmental control on the petrology of a Late Holocene speleothem from Botswana with annual layers of aragonite and calcite: Journal of Sedimentary Research, 1994, A64, 1.

9. Turner,F.J.,and Weiss,L.E., Structural analysis of metamorphic tectonites .New York: McGraw- Hill. 1963 , p 545.

10. Hoek, E., Influence of Rock Structure on Stability of Rock Slopes. In: C.O. Brawner and U. Milligan (eds.): Stability in open Pit Mining. Proc. 1st conf. On Stability in open Pit Mining. Van Cover, Canada. 1971a. pp. (49- 63).

11. Hamasur, G. A., Engineering Geological Study of Rock Slope Stability in Haibat-Sultan Mountain. NE- Iraq, Unpub. M. Sc. Thesis, Univer. of Salahaddin 1991. (p.152)

12. Al- Saadi, N., A method for mapping unstable slopes with reference to the coastline of S. W. Dyfed, Wales. Unpub. Ph. D. Thesis, Univerity of Bristol, 1981, p. 252

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