------ Raf. Jour. Sci., Vol.16, No.2 Geology, Special Issue, pp.26-34, 2005 ------

Origin of Some Limestone and Gypsum Natural Bridges at Northern Iraq

Bassam M.Al-Dewachi
Remote Sensing Center
Mosul University

(Received 2/6/2004 , Accepted 2/1/2005)

ABSTRACT

The present study investigates the location and origin of some natural bridges in northern Iraq. They have been founded in two geological formations, the Sinjar and Al-Fa'tha formations. The rocks are consisting the bridges are in limestone and gypsum respectively.

The natural bridges have usually been considered as temporary phenomena with a short life span and, in general, have either major or minor sizes as in the case of the present study.

The rainfall and the underground water dissolved both the limestone and the gypsum rocks, which are considered classically as highly soluble rocks. The dissolution of rocks, especially their sub-surfaces, caused an underground tunnels and channels and parts of their roofs would collapsed, while the uncollapsed roofs, subsequently constitute natural bridges. The present study concluded that the origin of natural bridges is karstic, but other origins could be invoked. Usually the natural bridges at the present time considered as natural monument, which must be preserved and located on maps so that they could be used as tourists' attraction sites.

اصل بعض الجسور الطبيعية في الصخور الكلسية والجبسية في شمال العراق

الملخص

الدراسة الحالية بحثت في مواقع وأصل بعض الجسور الطبيعية في شمال العراق، هذه الجسور الطبيعية تم التعرف عليها وكذلك دراستها والموجودة في تكوينين جيولوجيين وهما تكوين سنجار و الفتحة. تم تحديد جسر طبيعي واحد في تكوين سنجار وذلك في الصخور الكلسية لهذا التكوين بينما تم تحديد عدة جسور في الصخور الجبسية في مناطق مختلفة ضمن تكوين الفتحة. تعتبر الجسور الطبيعية ظواهر او أشكال ارضية مؤقتة وذات عمر محدد وهي في العادة موجودة اما بحجم رئيسي او ثانوي كما هي الحال في شمال العراق.

ان كلاً من الأمطار الساقطة ومن ثم المياه الجوفية هي التي تعمل على تكوين قنوات ومجـاري تحـت سطح الأرض، و كنتيجة لذوبان الصخور ذات الاذابة العالية بالمياه مثل الصخور الجبسية ،الكلسية و الملحيـة فان بعضاً من سقوف هذه القنوات والمجاري ينهار جزء منها و الجزء الباقي وغير المنهار لحد الان هـو مـا يطلق عليه الجسور الطبيعية. توصلت الدراسة الحالية الى نتيجة مهمة وهـي ان هـذه الجسـور ذات اصـل كارستي علما انه هناك اصول مختلفة ومتنوعة يمكن ان تتسبب في تكوينها ايضا. تعتبـر الجسـور الطبيعيـة في الوقت الحاضر رموز طبيعية يجب المحافظة عليها وحمايتها ومن ثم اعداد خرائط خاصة لمواقعها و ذلـك لاستخدامها في ما بعد كمواقع للجذب السياحي.

INTRODUCTION

Natural bridge which is usually considered as temporary phenomena defined by Monroe and (Wicander, 1992) as "a variety of rock resulting from wave erosion, the partial collapse of cavern roof, parallel joint as in Archian national park in Utah (USA) and natural bridges that span a valley eroded by running water". (Moore, 1973) also defined the term as "A bridge or arch of natural rocks, sometime such a bridge is formed of valley spur cut through by stream. It is more common, however in limestone country where it is properly remnant of cave tunnel".

Both of the above definitions put emphasis on different origins of the natural bridges and one of them is the karstifcation as this is case of present study in northern Iraq. The natural bridges are identified within the Sinjar limestone rocks and in Al-Fat`ha gypsum rocks where in the later formation both major and the minor types are found. Also, Al-Fat`ha Formation contains numerous bridges of gypsum rocks which are studied by many authors such as: (Al-Sabti et al., 1989), (George, 1994), (Jibril, 1995), (Jassim et al., 1997), (Al-Dewachi, 2001) and (Al-Salim and Thabit, 2001).

The purpose of this study is to investigate the origin of these natural bridges in Northern Iraq.

INITIATION, DEVELOPMENT AND GEOGRAPHICAL-GEOLOGICAL SETTING OF THE NATURAL BRIDGES

Lithology is the main factor behind the initiation of karstic processes leading to natural bridges. The highly soluble rocks such as limestone, marly limestone and gypsum or non classic one such as conglomerate of calcareous-matrix (calcareous conglomerate), (Belloni, et al., 1972) must be available to initiate or start the processes of karstification and subsequent the karstic phenomena.

The first group of natural bridges were observed in Sinjar Limestone Formation that exposed at southern limb of Jabal Sinjar which is located about (100) km west of Mosul city (Fig.1). The Sinjar Limestone Formation assigned by (Al-Hashimi and Amer, 1985) to Paleocene-Lower Eocene is described as carbonates and representing platform (neritic facies). (Bellen et al., 1959) recognized three facies in ascending order, these are: Algal reef

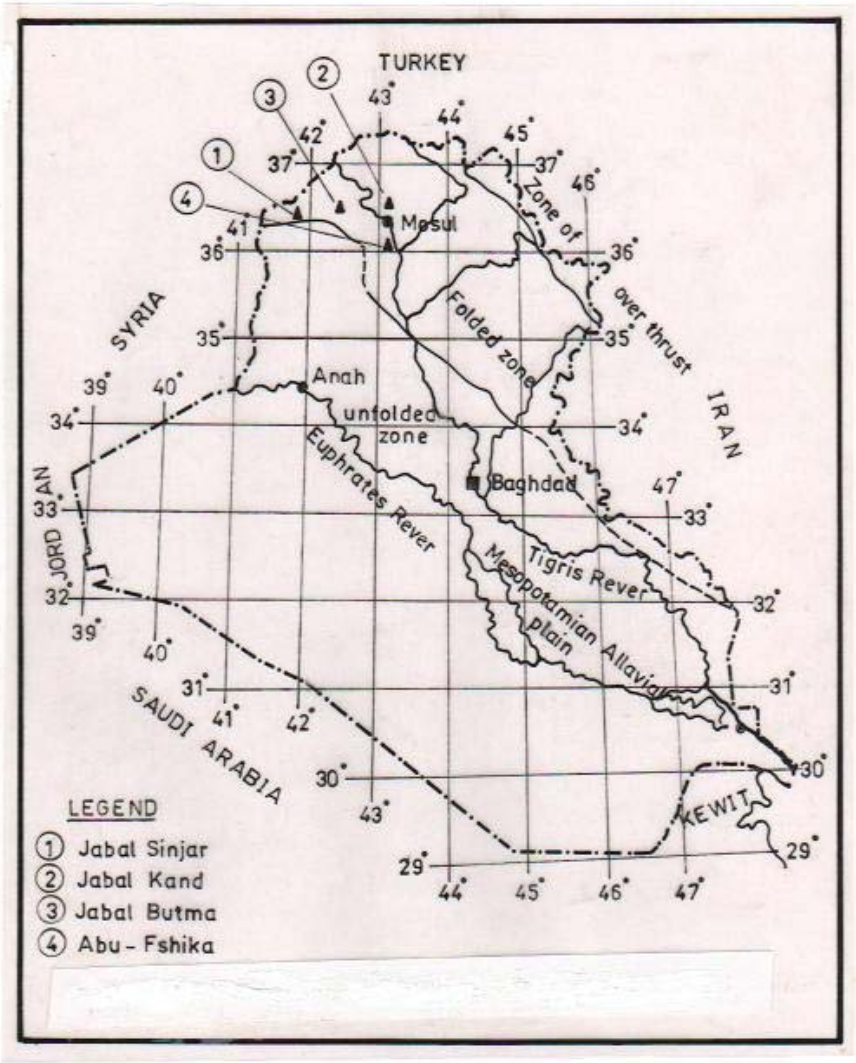

Fig.1: Location of natural bridges.

facies, in which the natural bridge is recognized (Plate.1) associated with numerous caves and caverns; lagoonal milliolid facies and shoal nummulitic facies. The last two facies are devoid of any kind of karstic forms and/or any natural bridges, possibly the rocks of these facies are less vulnerable to dissolution by groundwater.

The second occurrence of natural bridges are located at three different areas as shown in (Fig. 1) within gypsum of Al-Fa'tha Formation.

These localities appear at the southwestern limb of Jabal Kand, which is about (40) km. north east of Mosul City (Plate.2). An axillary analog occurs at Jabal Butma (Plate.3), which located about (60) km. north west of Mosul City (3 at Fig.1).

At Abu-Fshika village which is located to the south of Mosul city a distance about (40) km. along highway between Mosul and Baghdad (4 at Fig.1). These major natural bridges are the largest in size and number (Plates 4, 5 and 6). As well as, many other major karstic forms are founded also in gypsum rocks such as caves and sinkholes, in the area of study.

Al-Fa'tha formation assigned by (Al-Hashimi and Amer, 1985) as middle Miocene and described lithologically as alteration of gypsum and limestone in its lower part, where the most of karstic forms, including natural bridge founded in these gypsum rock. The upper part is composed of gypsum, limestone and clay. The karstic forms are very rare in the gypsum rocks in this part of the formation. This probably due to variable texture of gypsum rock of these two parts, also the thickness of the beds which is described as very thick in the lower part and thin to very thin in the upper part could be the reason, (Selby, 1985).

The above discussion indicates highly soluble rocks in the two formation are available, and this condition necessary prior to any karstic process initiation. The other factors or conditions for karstification process to be initiated and developed is the validity of high rainfall and then high quantity of ground water flows. The natural bridges in northern Iraq found in semi-arid climate in which the annual rain fall is between (400-600) mm (Tamar-Agha, 1985). (Selby, 1985) concluded that in semi arid and arid climate region there is too little water for much solution to form karstic landforms.

(Chapman, 1976), (Al-Sabti et al., 1989) and (Al-Dewachi, 2001) assigned the Pliestocene-Holocene time as been a wet climate promoting the initiation and development of high rate of rain water and then high underground water flow. The underground or running water naturally somewhat acidic, because of carbon dioxide in the air react with water to form carbonic acid, so both limestone and gypsum, are readily dissolved by infiltrating rain water.

Tectonically, all the natural bridges identified in the present study are located within the simple folded zone (Dunnington, 1958) or the unstable shelf zone of (Buday and Jassim, 1987) and were most of the rocks their are highly jointed and fractures. Joints as a zone of weakness can accelerate the infiltration as well as the surface water (Selby, 1985). Over long periods of time, underground water may dissolve large volume, of limestone or gypsum and slowly enlarge underground tunnels and, channels and eroding the support rocks from the land above. Continuation, parts of the roof of these tunnels and channels may collapse completely.

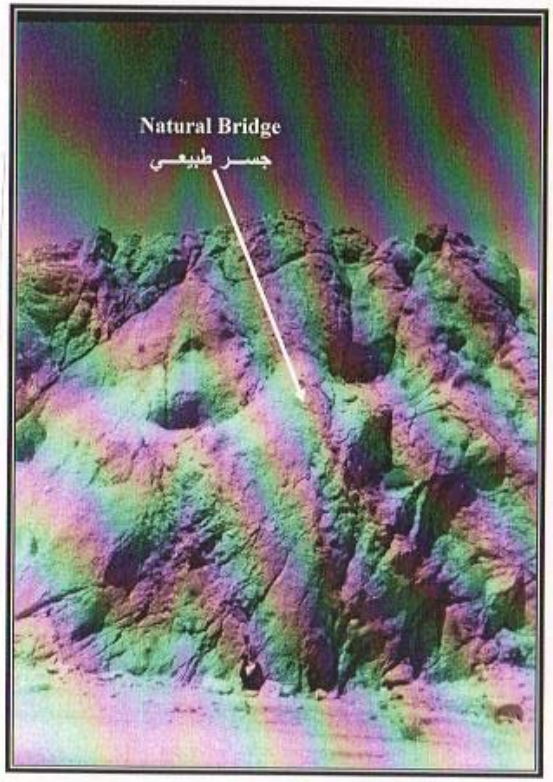

Plate 1: Natural bridge of Limestone at the southern limb of Sinjar anticline .

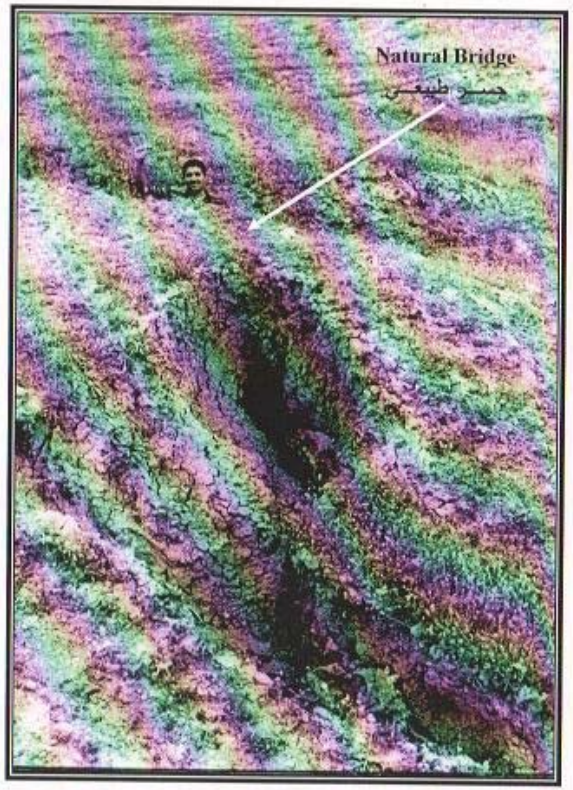

Plate 2: Natural bridge of Gypsum at the northwestern limb of Kand anticline .

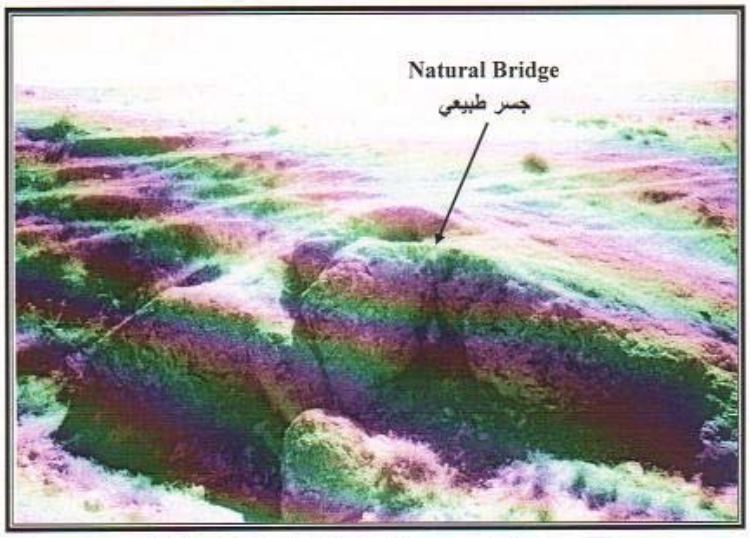

Plate 3: Natural bridge of Gypsum at the southern limb of Butmah anticline

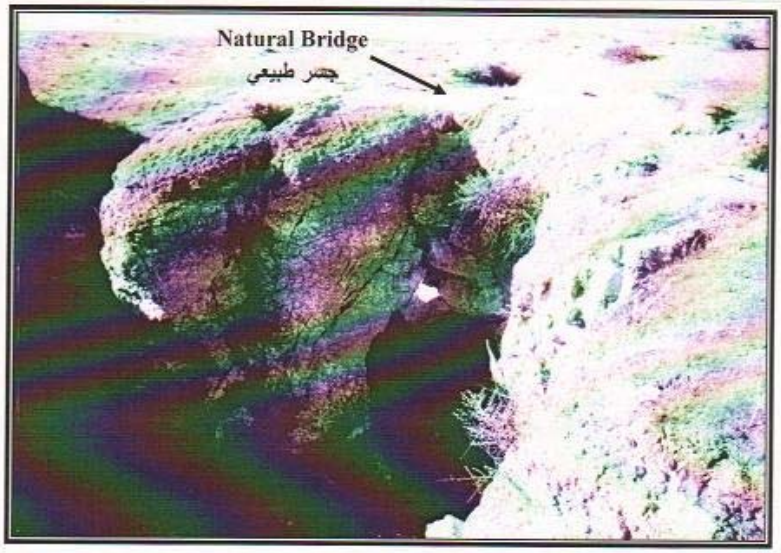

Plate 4: Natural bridge of Gypsum at Abu-Fshika village anticline .

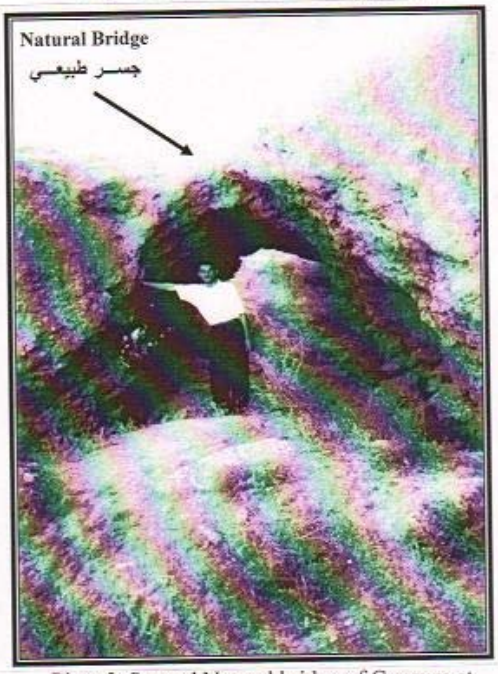

Plate 5: Second Natural bridge of Gypsum at Abu-Fshika village.

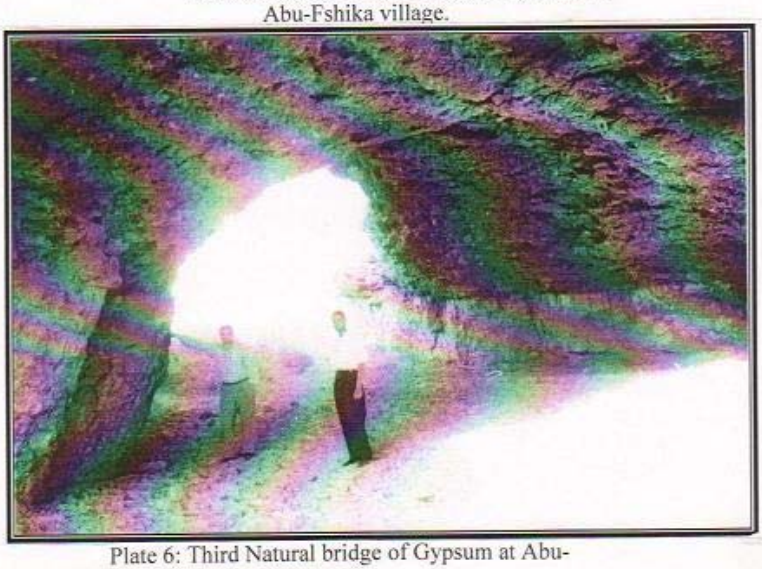

Plate 6: Third Natural bridge of Gypsum at Abu-Fshika village.

The gravity could help in where some parts of the roof sustain cohesion and remain not collapsed. These parts of the roof form the phenomena of natural bridges of karstic origin (Montgomery, 1997).

CONCLUSIONS

1- Natural bridges in, limstone and gypsum were identified in the Sinjar and Al-Fat'ha formation at northern Iraq.
2- The natural bridges in northern Iraq are of karstic origin and usually found accompanied by other karstic forms such as caves and sinkholes.
3- The present climatic condition of northern Iraq (semi-arid) is not held responsible for the initiation of the natural bridges associated with the other phenomena of karstic origin because of low average of annual rain fall which ranges between (400-600)mm. The wet climate of interpluvial Pliestocene- Holocene time is probably responsible for the initiation and development of natural bridges and other karstic forms.
4- The high quantity of rain ducing fall Pliestocene-Holocene time becoming acidic, and induced the dissolution of limestone and gypsum channels and tunnels which continue to be enlarged with time. Parts of roof of these underground tunnels and channels are collapsed by dissolution - gravity or both while other parts did are not collapse and sustained their cohesions. These parts of the roofs formed the natural bridges of karstic origin.

REFERENCES

Al-Dewachi, M. Bassam, 2001.A study of the initiation and development of valley network in general and blind and karstic especially at jabal sheikh Ibrahim Nw of Mosul /Iraq , Iraq Journal of Earth Science ,Vol.1, No.2, pp.11-22 (in Arabic).

Al-Hashimi, H. and Amer, R., 1985. Tertiary Microfacies of Iraq, published and printed by D. Ggeological Survey and Mining Investigation, 195p.

Al-Sabti, G.M., Jareshan, J.H. and Abdul karim, S., 1989. Gypsum karst in Sulavani area, North-west Iraq. Iraq Journal of Science, Vol.30, No.3, pp.357-369.

Al-Salim, H.T. and Thabet M.A.K, 2001.Undergrouned Cavities In Al-Mogher, South of Mosul City–A case Study. Raf. Jour. Sci., Vol.12, No.3, pp.66-75.

Bellen, R.C. Van, Dunnington, V.H., Wetzel, R. and Morton, D., 1959. Lexiques stratigraphique International, Asia, fasc., Iraq, Paris, 109p.

Belloni, S., Martinis, 1972. Karst of Italy, in Karst, Important Karst Regions of the Northern Hemisphere. Herak .M. and Stringfield, V.T. (Editors), Elsevier Publishing Company, 551p.

Buday, T. and Jassim, S., 1987. The Regional Geology of Iraq (Magmatism and Metamorphism. D.G. of Geol. Sur. and Min. Inv., Baghdad, Iraq, 350p.

Chapman, R.W., 1976. Calcerous douricrust in Al-Hasa, Saudi Arabic. Bull. Geol. Soc. Am., Vol.85, pp.119-130.

Dunnington, H.B., 1958. Generation, Migration, Accumulation and Deception of Oil in Northern Iraq, in Geological productivity, selected reprinted from A.A.P.G., foreign reprint serious No.2, pp.62-119.

Jassim, S.Z., Jibril, A. and Numan, N.M., 1997. Gypsum karstification in middle Miocene Fat'ha Formation, Mosul area northern Iraq. Geomorphology, Vol.18, pp.137-149.

Jibril, A., 1995. The use of remote sensing techniques to study the karstic phenomenas in Mosul region, unpublished M.Sc. Thesis, Remote Sensing Center, Mosul University, 173p (in Arabic).

Monroe, S. Janes and Wicander Reed, 1992. Physical Geology–Explorating the Earth ,West Publishing Company, 638p.

Montgomery, W. Carla, 1997. Fundamentals of Geology, Third edition, W.M.C. Brow publisher, 412p.

Moore, W.G., 1973. Adictionary of geography, Definition and Explanation of Terms used in physical geography, Penguin Books, 234p.

Tamar-Agha, Y. M., 1985. The Role of Ground Water in the Growth of Authogenic Minerals in the Soil of South Singar Plain, NW Iraq, Journal of Geological Society of Iraq, Vol.18, No.1, pp.197-217.