New Findings On The Karst In Nubia Sandstone Southern Egypt

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Abstract-This article posters new Karst findings within the quartzose arenite Nubia sandstone with field evidences, and discussion of Karst within sandstone southern Egypt with consider to Holocene water periods. The morphological description, process and their possible origins will be investigate. The karstic process in Nubia sandstone was easy due to vertical joints, weak bedding planes in horizontal succession and high permeability. [Nature and Science 2010;8(8):125-129]. (ISSN: 1545-0740).

Key words' karst, Formation, Nubia, sandstone

1-Introduction

In last decades Karst and Karen caves in quartzose arenite sandstone have been existed as a new landform in Australia, Tchad and Niger. The dominant vertical jointing of the quartz sandstone and relatively high permeability of the sandstone are important karst process. Solutional weathering of the sandstone is widespread, and followed by the removal of loosened sand grains by flowing underground water, the process of 'arenisation'. Caves development would appear to have been happening for a very long time, and may still be occurring. Further studies of karst caves or 'arenisation'(in the terms of [8&9]). The Crtaceous Nubia sandstone (NSS) widely extended in north Sudan and southern Egypt, stretched northward to Latitude 27º.

2- Methodology

The Nubia sandstone was extracted from the available geological maps of southern Egypt [3]. In order to understand the water action on sandstone, the drainage pattern and flow direction in and the spatially variable reliefs southern Egypt were interpreted from visual analyses of Landsat TM images. The sandstone properties also postulated. The tectonic control on Cretaceous Nubia sandstone was implied given the influence of structural lineaments on water through the fractures. Usually, the dominant NE and NW structural trends in southern Egypt have intersected giving fractures and joints in several directions. Consequently, the horizontal bedding of Nubia sandstone plateau affected with vertical joints that allow water for chemical and physical weathering process. Moreover, the impact of changing hydro-climatic conditions in this region during the Holocene pluvial cycles was also considered. Moreover, the properties of NSS from integrating geological and petrographical data were determined. Overall, the physical properties of sandstone, morph-tectonic and Holocene hydro-climatic developments in water catchments will be use to assess the karst in Nubia sandstone southern Egypt.

3- Nubia Sandstone

Over a kilometer in the Nubian strata were deposited in south western Egypt controlled primarily by marine transgressions and regressions with alluvial plain sand with interbedded channel and soil zone deposits interleaved with marine clay and silt. These cycle constitute the typical Nubia sandstone and represent continuously changing environments from fluvial and deltaic deposition [6].

Quartzose Nubia sandstone, the name has been used indiscriminately as proposed by early workers in the vicinity of Aswan, comprises five successive lithofacies dominated by quartzose sandstone [15], the fedspars less than 5%100 in the lower facies and reach up to some 15%100 in upper facies in the northern borders. Cretaceous sandstone outcropped in Kurusku plateau around Lake Nasser southern Egypt. The exposed Nubia sandstone divided into formations (F) named (from older to younger); Abu Aggag F-, Timsah F, Umm BrammilyF and Quseir F[3]. Abu Aggag Formation stretched in N-S lagre belt of horizontal beds covering Kurkur area and in the east of Aswan. It composed of fluvial deposits with cross-bedded sandstones, ripple-laminated sandstone, lenticular sand bodies and channel fills and locally paleosols. At the south of Western Desert, the Sabaya Formation composed of medium to coarse grained flood plain sandstone with interbedded channel dseposits and soil horizons, may be transitional to Abu Aggag F. Timsah F outcropped in south eastern desert, it composed of fluviatile near-shore marine and locally eolian sanstone, fine-to medium-grained with interbedded channel and soil deposits. Umm Brammily F overlie unconformably the Abu Aggag F, it composed of fluviatile sandstone, becoming more marine towards the north. Quseir Formation cover a wide area to the north

of Aswan. Their thickness vary from 280m and reach up to 425m in the north. Quseir F composed of littoral vary colored shale, siltstone, and flagy sandstone containing mixed marine and fresh-water gastropods. The chalk, marl and calc-arenite sequence in northeast Aswan is an indication to shallow open seas rather than the estuarine littoral environment.

There is a wide agreement that Cretaceous sandstone considered the main underground water aquifer in Egypt, fracture enough for springs and productive water wells from this water reservoir. Ulf-[14] stated that sandstone aquifer extended about 630 000 km^2 in Egypt. In the field work, several water wells (Bir s) have fresh water, people use it in their road from Aswan to Sudan such as Birs Abrqu, Umm Hebal, Gahelia, Rihaba, in the southeastern Desert. In Nubia sandstone, Ulf-[14] stated that "the groundwater of the Nubian aquifer was formed mainly by local infiltration". This my help to understanding the water flow within this sandstones are therefore warranted, especially those forming part of major groundwater aquifers in Egypt or similar countries. Karst findings highlight our potentially of groundwater flow within Nubia sandstone aquifer may have new important groundwater assessment.

4-The Holocene Rain Period On Egypt

Palaeoenvironmental changes, consider as multiple lines of converging evidence for hydroclimatic change during the Late Quaternary and briefly recounts the recent environment history of Egyptian desert. The today dry land in
south Egypt was formerly rainy in Holocene, water was common for fracture and drainage system that was going to the Nile Valley. [2] stated that during Late Pleistocene much of North Africa was hyperarid climate, Nicoll [10] postulated that during the Late Pleistocene, most of Egypt and northern Sudan was internally drained and run-off accumulated within disjunctive internal drainage divides and deflation hollows. The Early Holocene was characterized by the advent of water conditions across much of Egypt and northern Sudan [5]. Meanwhile, in the more southerly reaches of Egypt, rain-fed playas filled up with water around the middle of the millennium BP [10]. In addition, the Neonile δ started after the global rise of temperature (from 13500 to 11500 BP), the rain fall was increased with beginning of Holocene (10000 years ago) which lead to rise of water level. About of 25000 BC, the flood plain is higher than the present flood plain of Neonile δ that are present in Kom Ombo and plain and Wadi Kobaniya to the north of Aswan [13]. Moreover, the exposure of water bodies in Kurkur area far from the lake and occurrences of gypsum patches delineate the high ground water table in Kurkur basin during Holocene.

In the new decades, many climate researchers consensus that Middle Holocene was rainy period on north Africa. For example, Wang [18] performed
two climatic models in the mid- Holocene total vegetation cover, mainly perennial grassland has
extended farther north into the Sahara region in both models. When the large-scale background climatic conditions change from wetter to drier from the mid-Holocene to pre-industrial and/or present-day, It is clear that the top soil is wetter in mid-Holocene run. This wetter soil corresponds to a higher rainfall in mid-Holocene than that in pre-industrial. The wetter soil and higher rainfall conditions closely correspond to the negative feedback regions in mid-Holocene. [18]. Moreover, consensus that during the Holocene optimum until some 6000 years ago, the Sahara was much greener than today Overall the karst in sandstone can asses in consideration to the water rains in Middle Holocene. This karstic process in Nubia sandstone difficult to proceed in Tertiary because of Miocene uplift tectonic movement and thick Tertiary limestone plateau which overlie the Nubia sandstone.

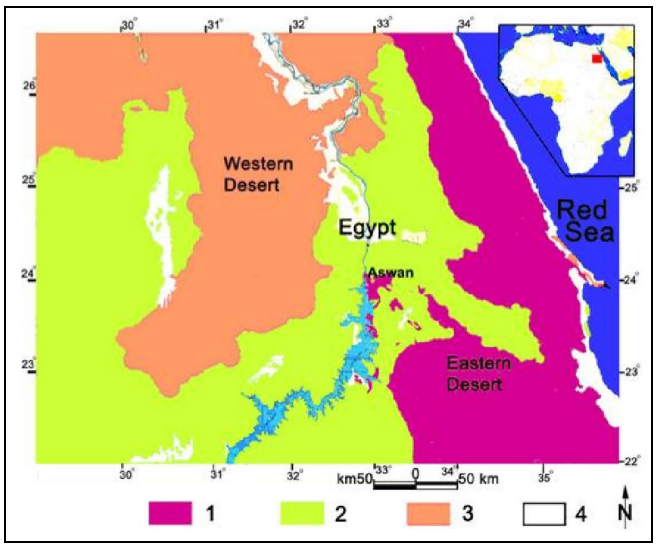

Figure.1, Location map of sandstone south Egypt, simplified from CONOCOmap, 1987, 1;basement rocks, 2; sandstone, 3; Tertiary carbonate rocks and 4; Quaternary deposits.

5- Drainage Within Nubia Sandstone

The water flow going to the Nile valley from both east and west in drainage basins. The igneous and metamorphic mountains in the basin has steep slopes and not infiltrate the precipitated water giving quick runoff to Nubia sandstone. This basin declined from 1300 m asl at the basement mountains then sloped to 600 m asl in the downstream in Nubia sandstone this system allowed for hydraulic action in chemical and physical weathering. Dissolution Rainfall is acidic because atmospheric carbon dioxide dissolves in the

rainwater producing weak carbonic acid. The chemical and physical weathering often go hand in hand. Furthermore, the chemical action at minerals in cracks can aid the disintegration process. Sandstone was found in hydrolysis is a chemical weathering process affecting silicate and carbonate minerals. In such reactions, pure water ionizes
slightly and reacts with silicate minerals [19]. Slow chemical dissolution of quartz occurs, especially along drystal boundaries. This frees individual grains, and the rock becomes less coherent and susceptable to physical erosion, sand grains are mechanically removed A plentiful flow of water in the vadose zone leads to piping and removal of rock bulk [8&20]. Rates of aquifer recharge and discharge, or the management of flows at water supply bores. Further studies of water flow within this and other sandstones are therefore warranted, especially those forming part of major groundwater aquifers in arid countries [17]. This hydraulic system ensure the karst potential in Nubia sandstone. Karstic process took placed and karst landform founded in Nubia sandstone due to many factors such as; vertical joints, week bedding plane in horizontal succession, and high permeability. This also lead to Precipice sandstone in kurkur area western desert (Fig.5,b). Lateral spacing between the vertical joints changes from location to another through the sandstone. The water resurges horizontally from Nubia sandstone may be abandoned conduits may network within Nubia sandstone. May be in further studies, karst mechanism in Nubia sandstone format the highly dissected Kurusku plateau explained similar to that in limestone plateau which overlie and exposed to the north of Nubia sandstone including the columnar landform in limestone abundant in western desert.

6- Description Of Karst Landforms In Nubia Sandstone South Egypt

The karst landforms present in Nubia sandstone including caves, columnar in different sizes. There are caves at the end of the vertical joints that is the rain water passage (Fig.2&5). Other caves not found along the fracture plain but it seen excavation inside the sandstone blocks (Fig.2& 5). In southesstern desert, the caves in Nubia sandstone Kurusku plateau, has width 2 m and height 1m and width 1 m and height 1.5 m and width 0.6 m and height 0.5 m (Fig. 2,3&4). Sandstone towers in quartzose Nubia sandstone to the northeast of Aswan is interaction processes leading to karst development (Fig.4). Sandstone column in southern Egypt exhibit drainage net similar in many ways to limestone. In Western Desert, there is Karst in width 75 cm and height 45 cm and width 1 m and height 1.5 m and width 0.6 m and height 0.5 m (Fig.5,a). Kurkur area in Western Desert, the Karst at the lower end of joints in width 70 cm and height 40 cm and width 1 m and height 1.5 m and width 0.6 m and height 0.5 m (Fig.5a &b). Field evidence from the quartzose precipice sandstone in the quartzose precipice sandstone in the Western Desert (Fig.5,b).

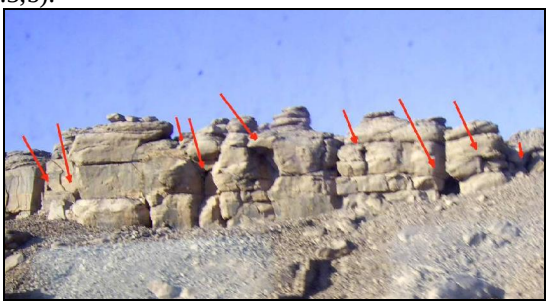

Figure. 2, Photograph shows karst in Nubia sandstone southeastern desert, along vertical joints and inside the block.

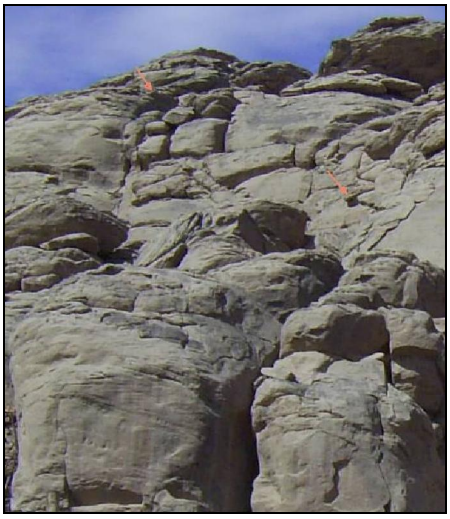

Figure. 3. Photographs show Karst in Nubia sandstone southeastern desert.

Figure. 4, Photograph shows sandstone towers in Nubia sandstone northeast Aswan.

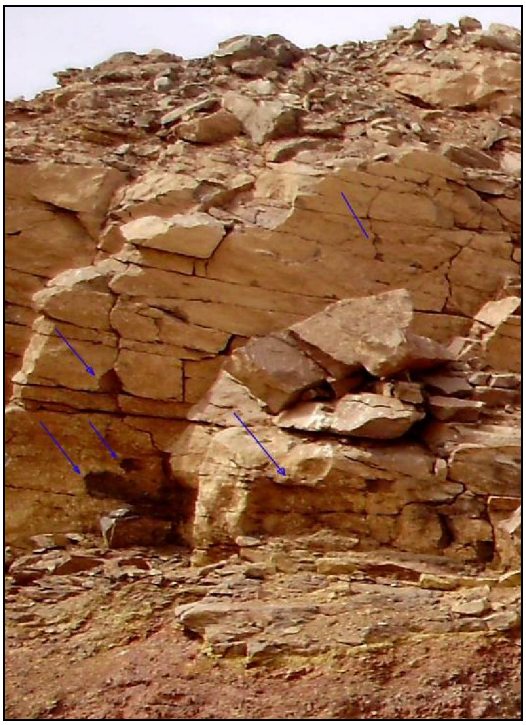

Figure. 5, Photograph shows Karst in Nubia sandstone south Western Desert Egypt, 5-a, Karst along vertical joints and inside block. 5-b, re-cemented limb of the tube opening with sandstones.

7- Discussion And Conclusions

In Australia, Wray [17] reported with field evidences karst as phreatic drainage conduits within quartz sandstone in Australia, that such karst terminology was also used by [1&12], for sandstones with similar conduits in northern and central Africa. The potential also exists for similar concentrated conduit flow within many other quartz sandstone aquifers, and clearly shows that the general assumption of diffuse flow, or even unorganized fracture flow, within quartz sandstones may sometimes be in error whilst needs further modern investigations [17]. Several important implications stem from this discovery of widespread karst development potentially sandstones. First, it can explain the columnar sandstone hills spread in southern Western Desert weathered and giving horizontal conical hills. In addition, some of them are arranged in circular-shape. In Eastern Desert, the Kurusku plateau high dissected giving drainage pattern that similar in Limestone. Second, it adds another example from arid country (Egypt) while in Australia to the small but growing group of karstic drainage networks now being recognized within quartz sandstones worldwide.

It also adds to our understanding of the important landscape implications of the slow near-surface dissolution of quartz; 'arenisation' in the terms of [8&9], which results in a rock that eventually becomes incoherent and is thus more susceptible to physical erosion by flowing water than the original rock. Because solution has been a critical genetic process, the use of the term 'karst' is justified here [16, 17 &20]. There may therefore be important consequences management of groundwater contamination [4]. In Niger, [1,&12]. And in Tchad**,** [7] postulated caves and minor sub-horizontal phreatic tubes in sandstone that may have acted as inputs and assist the movement of water into their surface

horizontal tube. whilst the area of sandstone aquifer extended about 630 000 km^2 in Egypt may in further studies. The natural discharge of Nubia aquifer takes place in different ways: overflow to the Nile, delivery of springs in depressions evaporation in areas where the ground water table is close to the surface[14]. In Abraqu area, water not pumped vertical as the normal spring but the water derived laterally from the sandstone rocks and collected down on sandstone terrain where the Bedween people called 'Maya el-Hagar'(Arabic, rock water), this water continuously discharged good water from Pharaoh time till recent, the water may be coming from a canyon karst in sandstone. Therefore, the water in Nubia sandstone may have recommended to further studies according to this modern landform and geomorphic process.

In Nubia sandstone,Ulf-[14] stated that "the groundwater of the Nubian aquifer was formed mainly by local infiltration", this my help to understanding the water flow within Nubia sandstones. In addition, the consensus that during the Holocene optimum, the Sahara was much greener than today. The drainage basins on both eastern and western side of the Nile drained from basement mountains to the Nubia sandstone plateau. Moreover, the karstic process easy due to many factors including vertical joints, bedding plane in horizontal succession, and high permeability. Consequently, this hydraulic system ensure the karst potential in Nubia sandstone and may also lead to precipice sandstone. Overall the karst in sandstone assessed in consideration to the water rains in Middle Holocene. This first work in Egypt may give a way for further studies support our potentially of groundwater flow within Nubia sandstone and may have new aquifer findings.

References

1 Busche D., Erbe W. Silicate karst landforms of the southernmSaharam. Zeitschrift für Geomorphologie Supplement, 1987; 64, 55–72.

2 Close A. and Wendorf F. North Africa at 18,000 BP In: Gamble.C Soffer O (eds.). The World at 18,000 BP Unwin Hyman Boston, 1990; pp 40 -57.

3 CONOCO Coral Petroleum Company. Geological map of Egypt, scale1:5,00,000, 1987.

4 Drew, D., Hotzl, H. Karst hydrogeology and human activities: impacts, consequences and implications. IAH International Contributions to Hydrogeology, 1998; 20. DA Publishers.

5 Haynes Jr .C.V. Geochronology and climate of the Pleistocene Holocene transition in the Darb el Arba in desert Eastern Sahara . Georchacology, 2001; 16, pp 119 – 142

6 Klitzsch E. Northwestern Sudan and bordering areas; geological development since Cambrian time Berliner GeeowissAbh, V. 50 (A), 1984; pp.23-45.

7 Mainguet MLe Modelé des Grès. Insitute Géogaphique Nationale, Paris, 1972; 657 p.

8 Martini, J.E.J Karst in Black Reef Quartzite near Kaapsehoop, Eastern Transvaal. Annals of the South African Geo. Survey, 1979; 13, 115–128.

9 Martini J.E.J. Dissolution of quartz and silicate minerals. In: Klimchouk, A., Ford, D.C., Palmer, A.N., Dreybrodt,W. (Eds.), Speleogenesis. Evolution of karst aquifers. National Speleological Society, Huntsville, 2000; 527

10 Nicoll K. Recent environmental change and prehistoric human activity in Egypt and north Sudan Quaternary Science Reviews, 23, 2004; pp 561-580.

11 Prentice I.C.and Jolly, DMid-Holocene and glacial-maximum vegetation geography of the northern continents and Africa. J Biogeography, 2000; 27, 507-519.

12 Sponholz,B. Sandstone karst and palaeo-sandstone weathering; its palaeo-environmental implication and Holocene impact on groundwater flow (Abstract), Congress of the International Union for Quaternry Research, Wuerzburg, 2003.

13 Said R., The River Nile. Pergamon press New York, 1993,

14 Ulf Thorweihe. Nubian aquifer system (from Said ed, 1990). The Geology of Egypt. Balkema Rotterdam Brookfield, 1990.

15 Van Houten,F.B. and Bhattacharyya D.P.,1979. LateCretaceous Nubia formation at Aswan southeastern desert Egypt. Annals. geological survey, Egypt v. IX, pp 408-431.

16 Wray R.A.L. A global review of solutional weathering forms on quartz sandstones. Earth Science Reviews , 1997; 42, 137–160.

17 Wray,R.A.L. Phreatic drainage conduits within quartz sandstone: Evidence from the Jurassic. Precipice Sandstone, Carnarvon Range, Queensland, Australia. Jour. Geomorphology, 2009; 110, 203–211

18 Wang Y., Notaro1 M., Gallimore Z., Liu, R., Levis S.,and Kutzbach J. E. Detecting vegetation-precipitation feedbacks in mid-Holocene North Africa from two climate models. Climate of the Past, 2008.; 4, 59–67, 20

19 Wikipedia. The free encyclopedia website, 2000.

20 Young R.W, Wray, R.A.L, and Young, A.R.M. Sandstone Landforms. Cambridge University Press, Cambridge, 2009; 314

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