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Tafoni phenomena in the Kerman Province of Iran: Short description and pictures

Brève description avec illustrations photographiques de phénomènes Tafoni dans la province de Kerman en Iran

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Résumé : La formation de tafoni dans la province de Kerman en Iran est présentée pour la première fois dans la note brève ci-après avec une galerie de photos illustrative. Les tafoni représentés se développent en plusieurs endroits dans différents matériaux rocheux: du basalte dans le désert de Lut, un champ volcanique du Plateau de Gandom Beryan, de l'andésite dans la grotte d'Ayub près de la ville de Dehaj, du tuf volcanique dans le village de Marj et du grès près de la ville de Hojedk.

Mots-clés: Iran, Province de Kerman, Formation de Tafoni, Différents matériaux rocheux

Abstract: Tafoni formation in the Kerman province of Iran is described for the first time in this paper illustrated by a pictures gallery. Tafoni develop in lots of areas in different rock types such as: basalt in the Lut desert, volcanic field of the Gandom Beryan Plateau , andesite in the Ayub cave near the town of Dehaj , tuff near the village of Marj and sandstone near the town of Hojedk

Keywords: Iran, Kerman province, Tafoni formation, Various rock types

INTRODUCTION

Because of thermal changes, mineral decomposition, water and wind action, and salt weathering, natural cavities called Tafoni develop in various (granular) rock types. These cavities are of different forms: spherical, ellipsoidal, kidney-shaped, pan to bowl shaped…

The origin of the word tafoni is uncertain; maybe it is derived from the Corsican dialect "tafone" and is synonymous with window (KLAER 1956). In geomorphology, tafoni refers to holes of a few decimeters to several meters wide. Despite numerous descriptions and explanations of tafoni formation from different areas of the world, the tafoni problem is still very controversial.

There are authors who interpret the tafoni weathering process as a chemical one, whereas others consider it rather to be a physical process. One point of view is that the formation of tafoni is in good connection with changes of moisture in the rock. ***Salt weathering*** (more physical process) and ***core weathering*** (more chemical process) may contribute to generate tafoni as well.

Tafoni are widely distributed around the world in diverse climates including humid, arid, hot, temperate and cold regions. Tafoni are often differentiated into different types: small, large, nested and honeycomb (MCBRIDE & PICARDE 2004). Tafoni originated as a result of differences in rock chemistry between the cavity filling and the enveloping rock. It seems that the formation of Tafoni is favoured by humidity and/or salt. In the case of an extreme arid area like that of Kerman it seems that development of tafoni comes probably under physical processes. The weathering forms cavities through the much easier erosion of softer material in the holes as compared to that of the enveloping harder rock material, such as plutonic and volcanic rocks.

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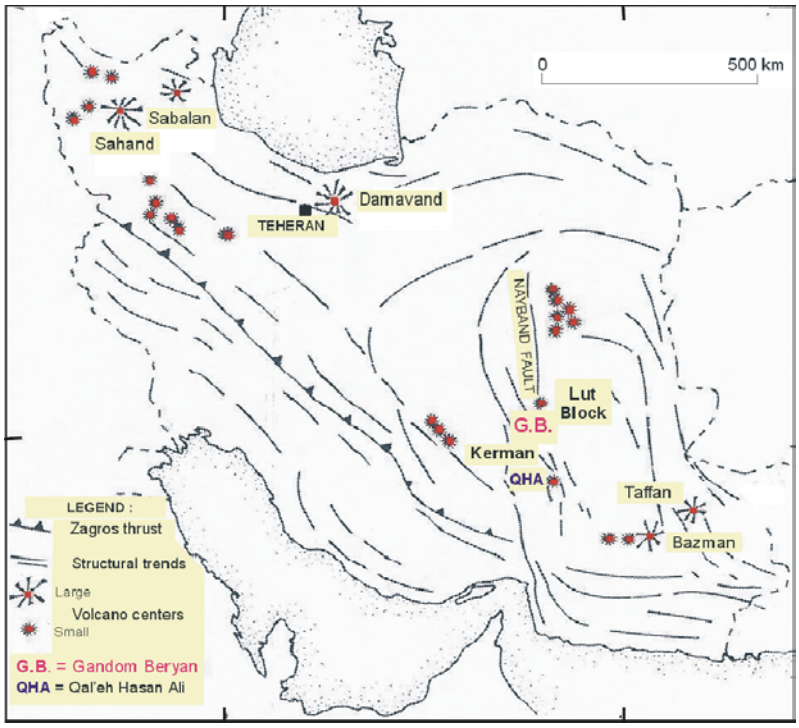

General map of the Quaternary volcanism in Iran
(adapted by the author after GANSSER, 1971 and MILTON, 1976/77).

TAFONI ON THE GANDOM BERYAN PLATEAU IN THE LUT DESERT ("HEAT POLE")

The Lut desert (heat pole) is located in northeastern Kerman and is one of the greatest desert basins on earth with a warm and dry (arid) climate with, as result, exceptional erosion phenomena triggered by extreme thermal changes and wind activity. This also applies to tectonic processes involved in erosion (80 km by 145 km). The resulting erosion forms are more than 100m high in some locations. The characteristic ones (fig.1) develop within younger strata covering older bedrock (the Lut block: see map).

The Gandom Beryan (toasted wheat) Plateau in the Lut desert is located northeastern of Kerman. It belongs to a volcanic field (the Lut volcanoes, figs.2-3) composed of almost homogenous dark, young basaltic lava rocks. It is an ideal place of observations for geologists, volcanologists and nature lovers (480 square kilometers).

The climate of the Gandom Beryan Plateau in the Lut desert is extremely dry (arid) and hot. Moreover, the heating up is intensified by the occurrence of dark-colored volcanic rocks without any vegetation cover. But even under these extreme circumstances, life forms do exist (Gandom Beryan). Because of their dark color, the volcanic rocks have an important heat storage capacity. The Gandon Beryan Plateau represents one of the warmest (surface temperature) and driest places in the world (fig.4).

The highest absolute surface temperature measurement in the Lut desert (Rigg Yelan zone) is 70,7°C (2005), measured by means of satellite data (NASA). This maximum-temperature-area (also called "Heat Pole") in the Lut desert changes during the year according to the position of the sun.

The former heat pole-measurement comes from the Australian outback area of Queensland (69,3 °C).

This indicates that the heat pole position can move to a large extent in the course of time.

TAFONI AT GANDOM BERYAN PLATEAU

The characteristic sand storms that frequently occur in the Gandom Beryan Plateau remove the loose material resulting from the above mechanical weathering, with subsequent continuous enlargement of the cavities. In this particular case, the almost total lack of water on the Plateau area should be stressed: this water will normally play an important role elsewhere on earth. Here on the Gandom Beryan Plateau, thermal weathering (also salt) represents the most important agent in tafoni formation (figs.5-7).

TAFONI AT HOJEDK CITY NORTH OF KERMAN

The Hojedk city is situated in the coal area of the Kerman province. The coal (sandy facies) belongs to the middle Jurassic in the Hojedk area (Hojedk Formation).

The Hojedk Formation (STÖCKLIN & STUDENIA, 1991) comprises a more than 1000m thick succession of shale, sandstone, conglomerate and coal horizons (Jh3 Member,Bathonian).

The pictures 8 to 11 show various forms of tafoni (small, large, long, wide, circular, oval) in of the Hojedk Formation.

TAFONI AT DEHAJ CITY IN THE AYUB CAVE WEST OF KERMAN

The Ayub volcanic cave is located on Ayub mountain in the south of the Dehaj city in the western area of the Kerman province. The Ayub mountain (3200m height) is part of the central Iranian mountain rangers.

The entrance of the Ayub cave is about 50m long and 40m high. The rocks of its walls consist of dacite-andesite and belong to Plio-Pleistocene time (fig.12).

The volcanic Ayub cave is one of the rare places in the world where tafoni natural phenomena can be observed in volcanic rocks and is one ideal place for geologists and natural scientists in search of tafoni forms (large, small, long, wide, circular, oval, nested, honeycomb). The pictures 13 to 19 show the various forms of tafoni present on the roof, walls, tunnel and outside the cave.

There are more tafoni phenomena in the volcanic rocks (tuff) in the Kerman province for example near the village of Marj (Western Kerman) fig.20.

CONCLUSION

The formation of tafoni in the Kerman province of Iran is showed for the first time in this paper. The tafoni are present in different areas on different forms and develop in various rock types such as basalt, andesite, tuff and sandstone.

In this work relating to the Kerman province it seems that it would be better, considering the extreme aridity of the area, to put forward the hypothesis of a weathering physical process for tafoni formation rather than a chemical one.

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Pictures Gallery

Fig.1: Erosion form, flat-bedded young strata covering old bedrock in the Lut desert).
Photo: I. ESCHGHI

Fig.2: The Lut desert showing the Gandom Beryan plateau in the background.
Photo: I. ESCHGHI

Fig.3: Gandom Beryan Plateau: lava field with basaltic lava. Photo: I. ESCHGHI

Fig.4: Volcanic rocks (basalt) with cracks (thermal wedges) as a result of the continuous temperature changes during day / night within the volcanic rocks of the Gandom Beryan Plateau (stone blocks ca.1m long). Photo: I. ESCHGHI

Fig.5: Volcanic rocks (basalt) with clearly weathering holes (tafoni), Gandom Beryan Plateau (stone blocks ca.1m long). Photo: I. ESCHGHI

Fig.6: Basalt rock with a regular circular tafoni,Gandom Beryan Plateau (stone blocks ca. 50cm long.). Photo: I. ESCHGHI

Fig.7: Basalt rock showing a deep tafoni, Gandom Beryan Plateau (stone blocks ca. 40cm). Photo: I. ESCHGHI

Fig.8: Sandstone wall (ca. 3,50m high) with various forms of tafoni at Hojedk. Photo: I. ESCHGHI

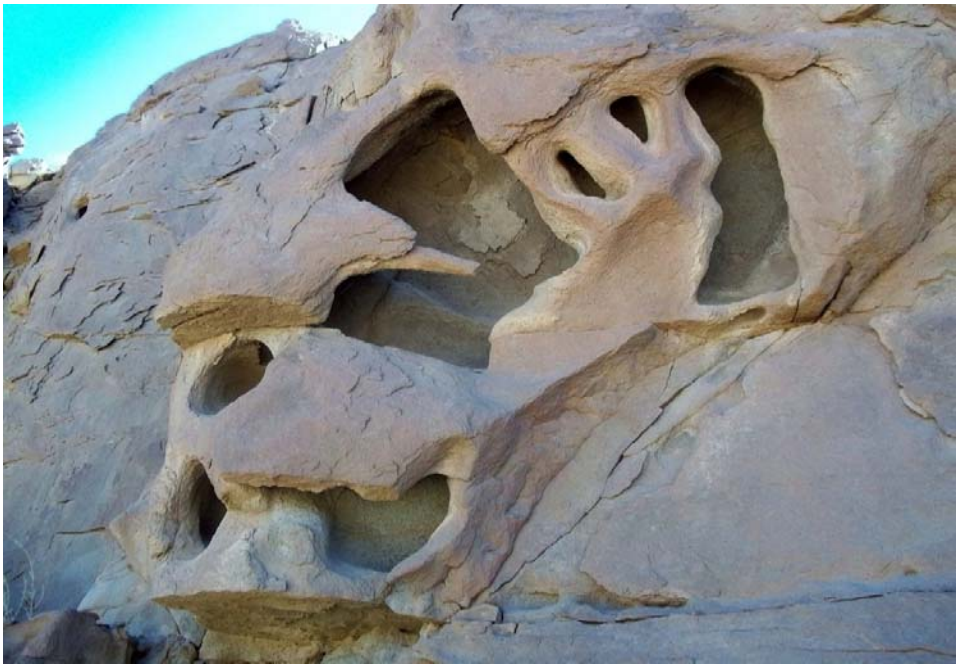

Fig.9: Tafoni hanging (ca. 2m) on sandstone wall at Hojedk.
Photo: I. ESCHGHI

Fig.10: Sandstone boulder (ca.2m high) with tafoni at Hojedk.
Photo: I. ESCHGHI

Fig.11: Sandstone layer (ca. 60cm. width) with circular and oval tafoni at Hojedk.
Photo : I. ESCHGHI

Fig.12: Volcanic Ayub cave with numerous of tafoni at Dehaj, west of Kerman.
Photo: I. ESCHGHI

Fig.13. Tafoni forms at Ayub cave roof. Photo: I. ESCHGHI

Fig.14: Tafoni with various forms at Ayub cave wall and cave roof.
Photo: A. KERMANI

Fig.15: Tafoni with various forms at Ayub cave (ca. 2m. width).
Photo: I. ESCHGHI

Fig.16: Tafoni at Ayub cave (ca.2m. width).
Photo: I. ESCHGHI

Fig.17: Ayub cave with tafoni forms at cave tunnel (ca.3.50m width). Photo: I. ESCHGHI

Fig.18: Great tafoni hole (ca.50cm. width) at Ayub cave outside. Photo: I. ESCHGHI

Fig.19: Complicated elongated volcanic rock boulder (covered with smale tafoni) form originated by weathering and showing good analogy with anthropogenous formed material at outside Ayub cave (ca.3m high). Photo: I. ESCHGHI

Fig.20: Volcanic rocks (tuff) with tafoni at Marj, west of Kerman. Photo: M. JAFARI