



Yet another attempt to explain the origin of the Baer Knolls in the Caspian Depression: insights from remote sensing data and field observations

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The Baer Knolls (BK) are parallel, nearly W-E trending hills, which developed in the Caspian Depression in the Late Quaternary and cover significant dryland areas from the Lower Kuma, the Lower Volga and further east to the Lower Emba River regions. They are typically 10-25 m in height, with a length reaching a few kilometers and a width of 100-500 m. Notably, the overall spatial distribution of the BK in the Caspian Depression is limited by the maximum level of the Late Khvalynian transgression of the Caspian Sea (20-10 ka) which is 0 m above present-day global sea level, whereas the Caspian Sea presently lies about -28 m.

The body of a typical BK consists of alternations of sandy-clayey sediments with a specific reddish-brown color and sub-horizontal bedding to multidirectional cross-bedding. The sedimentary sequence usually includes two members: (1) the lower sequence forms the core of a knoll and rests erosively on underlying Early Khvalynian sediments (mainly on so-called "chocolate" clays); and (2) the upper sequence which is usually draped upon the lower sequence and forms knoll flanks. There are very little lithological differences between these two members, however, the upper sequence distinctively contains more cross-bedding series.

Various scenarios have been suggested for the origin of the BK since mid-nineteenth century when they were first profoundly described by Karl Ernst von Baer (1856). Since then more than 80 papers have been published with different analysis of the distribution/orientation, structure, sedimentology/stratification and genesis of the BK. Hypotheses of their genesis proposed in these studies can be divided in the following groups: (1) aeolian; (2) marine (coastal and littoral); (3) erosion-accumulative (delta formation); (4) polygenetic geological factors (fluvial-aeolian, marine-aeolian etc.); and even (5) compressional tectonics. Nonetheless, by now there is no widely-accepted scenario for the development of the BK.

In this study, we make the 81st attempt to explain the origin of the BK. As was earlier suggested by Sedaykin (1977), the southern group of the BK within the Volga Delta traces to the west and distinctively merges with the remnants of the Late Khvalynian valley of the Volga River (so-called Sarpa River). Moreover, further north the distribution/orientation of the BK and small abandoned river channels in between the Volga and Sarpa rivers shows similar pattern. Together with a fact that the BK are exposed only within the extent of the Late Khvalynian transgression, this may indicate they could initially form as a result of sequential deltaic erosion during regression following the Late Khvalynian transgression. By the usage of modern remote sensing data we develop this earlier concept, however, some observations cannot be only explained by erosion-accumulative processes. In our opinion, the BK are the unique examples of fluvial/marine/aeolian interactions which acted throughout the Late Quaternary in the Caspian Depression.