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Pseudo-feathery dunes in the Kumtagh desert reclassified as linear dunes and zibars

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ABSTRACT

Dunes with apparent feathery patterns are common in the harsh and inaccessible Kumtagh desert in China. A recent paper by Dong et al. [Dong, Z., Qu, J., Wang, X., Qian, G., Luo, W., Wei, Z., 2008. Pseudo-feathery dunes in the Kumtagh desert. Geomorphology 100, 328–334] argued that the dunes are pseudo-feathery dunes with the different forms (linear versus marginal feather vanes) being related to grain composition differences. Field studies in the region and sedimentological analyses revealed that the dune 'feathers' are created by dunes of different heights, rather than by differences in material composition. The dunes are, in fact, linear dunes and zibars corresponding with the rachises and vanes, respectively, and appearing as feathery patterns in aerial photographs and satellite images.

The starting point for all aspects of desert dune geomorphology is the identification and description of different dune types (Lancaster, 1995). The aeolian bedforms in the northern Kumtagh desert are of long-term and general interests (Zhu et al., 1980; Wu, 2003; Qu et al., 2007; Dong et al., 2008; Liao et al., 2008). The previous interpretations on the aerial photographs, see Fig. 8–17 in Wu (2003) or Fig. 3 in Dong et al. (2008), indicated that the 'feathery' shaped dunes occur in the harsh and inaccessible Kumtagh desert. Several joint scientific expeditions since 2004 provided the opportunity to investigate the dune patterns in the field. By definition, the feathery dunes are a variety of compound linear dunes in which secondary ridges intersect or spread obliquely from the main ridge (McKee, 1979). The dune with this characteristic is scarcely found in the field. The dominant dune type is linear dune in the region of so-called feathery dunes. The height, spacing and grain size etc. of linear dune have been given by Qu et al. (2007), Liao et al. (2008) and Dong et al. (2008). However, it is still debatable which factor leads to vanes of feathery patterns in aerial photographs and satellite images. Recently, Dong et al. (2008) proposed that the inter-dune areas are flat and the feathery patterns are caused by differences in material composition. Their opinion was further reported by Reid (2008). In this letter, we give another interpretation of the appearance of 'feathery' dunes based on our three field surveys in the northern Kumtagh desert during Sep. 10–25 2007, May 20–29 2008 and Sep. 18–25 2008.

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First, the spatial distribution of 'bright sand drifts' in Dong et al. (2008) is irregular in the field. The grain size segregation really occurs between linear dunes. One can easily find the bright fine sands, almost simular to that of linear dune, in the downwind margins of obstacles such as stones and tents after a storm. In fact, Dong et al. (2008) only analyzed the aerial photographs and satellite images and did not provide any field data about the morphometry of 'bright sand drifts'.

Second, the inter-dune areas are not flat. Fig. 1 is an example of relative elevation, measured by using a total station (NTS-352), of inter-dune area. The survey line with the length of 1 km is parallel to linear dunes. The good corresponding relation between the bright/dark parts on the survey line in Fig. 1(a) and the high/low relative elevations in Fig. 1(b) shows that the 'feathers' are caused by reliefs of sand bed. We also measured the mineral composition of sediments in the inter-dune areas by X-ray diffraction method. It is very difficult or impossible to conclude that the feathery patterns are caused by differences in material composition from the disordered variation of mineral composition with grain size, see Tables 1 and 2 for detail.

Third, the vanes of feathery patterns in the aerial photographs and satellite images are actually zibars. Such low dunes in the corridors between higher dunes have often been observed in many other deserts (Cooke and Warren, 1973; Lancaster, 1995). Considering the wind records performed by Qu et al. (2007) and Liao et al. (2008), we find that the zibars occur on the upwind regions of Kumtagh desert and are transverse to the modern prevailing wind. The height and wavelength, thickness of zibar are about 1–2 m, 100–250 m and 7–8 m, respectively. The grain size analysis by dry sieve method suggests that zibars are composed of relative coarse and poorly sorted sands. Both coarse sands and very fine

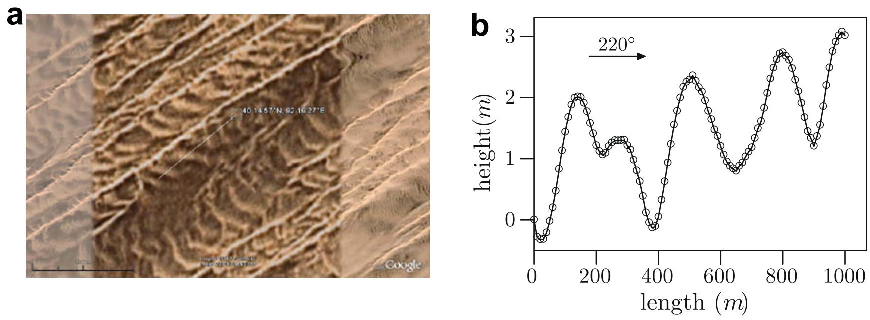

Fig. 1. Feathery pattern near (40°14′57″N, 92°19′27″E). (a) satellite images: the survey line is parallel to linear dunes, (b) relief of the inter-dune area.

Table 1
Mineral composition of the sediments in the depths of 0.0–1.0 cm.

Size (μm)	Semiquant of compound (%)						
	Quartz	Albite	Clinochlore	Anorthoclase	Muscovite2-ITM-RG- 1	Orthoclase	Other
(75,100]	27	27			37	9	1 (Calcite)
(100,180]	19	21			37	5	18 (Feldspar)
(180,380]	49	32			6	13	
(380,500]	17	10		9	64		
(500,700]	21	41			16	21	
(700,1000]	26	36		20	18		
(1000,1180]	46	25			20	9	
(1180,1430]	26	18	2		48	7	
(1430,2000]	27	21	3		41	8	
(2000,5000]	19	28			17	36	

Table 2
Grain size distribution and mineral composition of the sediments in the depths of 6.60–6.80 m.

Size (μm)	Mass fraction (%)	Semiquant of compound (%)						
		Quartz	Albite	Calcite	Dolomite	Muscovite2-ITM-RG- 1	Orthoclase	Other
[0,48]	2.506	12	30	4	2	31	21	
(48,75]	4.951	17	31	3	1	33	14	2 (Clinochlore)
(75,100]	5.513	18	33	2	1	35	11	
(100,180]	19.547	8	31		1	21	39	
(180,380]	40.249	26	17			46	11	
(380,500]	6.328	33	20			22	24	
(500,700]	11.595	48	25					27 (Anorthoclase)
(700,1000]	7.447	22	40			15		23 (Anorthoclase)
(1000,1180]	1.306	25	17			51	7	
(1180,2000]	0.550	31	7			52	10	
(2000,5000]	0.008							

pebbles are included. The deposition of fine sand in the lee of zibar is indistinct, see Fig. 2. The deep sand samples were obtained by using a hand auger. Below the surface layer of coarse sands, more fine to medium sands were found and the change of grain size with depth is indistinct until the base of zibar. Table 2, where the sands with the mean diameter of 300 μm or so are still not well sorted, lists the grain size distribution of the sediments in the depths of 6.60–6.80 m. The formation of zibar in the Kumtagh desert involves wind flow, sand characteristic, existence of linear dunes with relative large spatial scales, and underlying fluvial deposition etc. Here we only analyzed the grain size. The GPR profile we recently obtained indicates that the underlying relief could play an important role beside the interaction of wind and sand bed. However, more evidences are needed to validate this conclusion.

Both linear dune ('rachis') and zibar ('vane') are major dune types in the morphological classification of desert dunes (Lancaster, 1995). They have remarkable different spatial scales and prob-

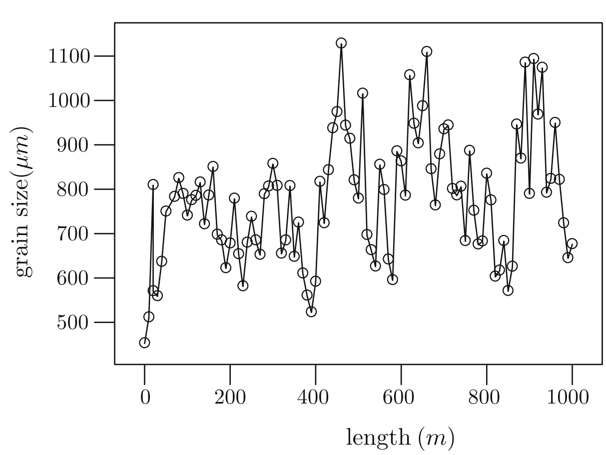

Fig. 2. The longitudinal change of mean size of surface grains.

ably follow different dynamics processes. So, it is not necessary to classify a new dune type although the feathery patterns in the satellite images of Kumtagh desert are fascinating.

In conclusion, the dune 'feathers' are caused by dunes of different heights, rather than by differences in material composition. The linear dunes and zibars correspond with the rachises and vanes of feathery patterns in aerial photographs and satellite images, respectively.

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