DISCUSSION

Comments on the paper **"Regional Stratigraphy of Quaternary Deposits in Parts of Thar Desert, Rajasthan"** by R. M. Sundaram, P. Rakshit and S. Pareek in Journal of Geological Society of India, Vol. 48, No. 2, pp. 203-210.

Much of the history of Quaternary era in the Thar desert is still shrouded in mystery. Therefore, any work on the subject, including Sundaram et al.'s article is welcome addition to the relatively small volume of published literature. One is not sure, however, if many of the sweeping statements by them are supported by good science. I shall restrict myself to their elucidation of the aeolian history from dune forms.

1. On page 205 the authors were emphatic that Kar (1993a) 'erroneously identified' to the south of Ghaggar valley a 'broad zone of transverse dunes showing intense gullying and dissection' as star dunes. Their statement is not supported by any argument or evidence, so it is difficult to guess what compelled them to think so. Interpretation of high resolution satellite images and aerial photographs of the area revealed at least two major differences with the transverse dunes: (i) absence of broad crescents along the dune crest with downwind opening, and (ii) joining of dune arms from different angles at regularly spaced peaks along the dune crest. Our studies on the morphology of transverse dunes across the desert suggest that both the high, old transverse dunes and the low, new ones are characterised by broad crescents at the crest, followed by a steep leeward slope. Additionally, the windward slopes of the old transverse dunes are characterised by linear, wind-parallel ribs. The newly formed low transverse dunes do not have such ribs. This phenomenon is noticed in other deserts of the world also. The transverse dunes form astride the direction of sand transport. The star dunes, on the other hand, have a pyramidal look, where the dune arms from different directions join at a central peak. If a number of such dunes form in close proximity of each other and are joined along the direction of maximum sand transport, then a linked star dune is noticed. The dune map in Kar (1993a) shows a location of old transverse dunes and star dunes in Chattargarh-Anupgarh-Suratgarh area. The pattern created by the arms joining at central nodes of star dunes was mapped separately to dispel any doubt about the type of the dune. The said article also argued with evidence that the past dune-forming wind and the present wind pattern may not be very dissimilar. Using long records of wind pattern over the region it was then shown that the sand-shifting summer wind comes from different directions in any given month in the Ganganagar-Suratgarh area, while the wind pattern to the south of it is progressively more unidirectional. Therefore, when all other factors remain almost similar, the variable wind creates a star pattern in Suratgarh area and transverse dune farther south. The details of the dunes can be better appreciated from high resolution images (~30 m) at 0.63-0.69 μm wavelength band (e. g. band 3 of Landsat TM). If the figure in Kar (1993a) was not enough proof of the pattern mapped from satellite images, I am providing here enlarged images of Landsat TM band 3 for the star dunes (Fig. 1) and transverse dunes (Fig. 2) in the area. Please note that unlike the old and high transverse dunes, the dune arms in the star dunes are multi-directional (A in Fig. 1) and are joining at a number of nodes (B in Fig. 1) along the broad crestal part of the dune. These nodes along the crest have a higher elevation (peaks). Channel dissection does not form such a pattern of joining arms at a central node. The wind-parallel ribs along the windward slope of the old transverse dunes (C in Fig. 2) have a different geometry. Both the types were last formed during an earlier dry climate and attained some degree of stability subsequently. There-

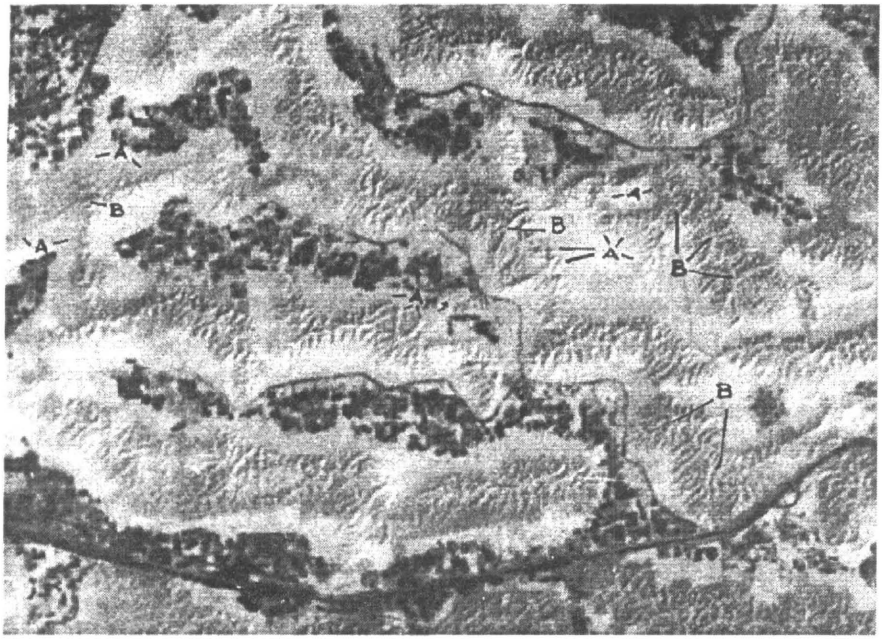

Fig.1. Landsat TM subscene of star dunefield near Sweatarh (149-040; 23 Feb., 1988). A, multi-directional dune forms; B, nodes where the arms meet.

Fig.2. Landsat TM subscene of transverse dunefield to the south of Chattargarh (149-040; 23 Feb., 1988). C, wind-parallel ribs along the windward slope of transeverse dunes.

fore, it is not uncommon to find a few channels along the geometry of these dunes, but those few channels can not significantly alter preferentially the geometry of some dunes, and leave the other dunes. One can not assume a large variation in rainfall in these adjacent dunefields, nor is it supported by meteorological records. Closer look at the images of the area reveals a spatial gradation from the transverse to the star pattern, which is consistent with the changing wind environment. Presently available images suggest that the star dunes may have a wider coverage than was mapped in Kar (1993a).

2. Sundaram et al. (1996) have also suggested how the different dunes could have formed over time. According to them, the parabolic dunes were formed first (Bikaner Formation). Then during a subsequent period the transverse dunes were formed (Churu Formation). The longitudinal dunes were formed in yet another period when the sand sheets and low sand mounds were formed (Sambar Formation). One wonders whether it is based on sound reasoning. It is inconceivable to suggest that only a single dune type was formed in a period, and that another type was formed in a subsequent period. This goes against the natural process-form interaction and is surely a false trend in science. Neither dating of the dunes (Chawla et al., 1991, Dhir et al., 1992), nor the arguments based on process-form interactions, confirm the thinking of Sundaram et al. that the three major dune types in the Thar, the parabolic, transverse and longitudinal, were formed in three different periods. Kar (1993a), to which Sundaram et al. (1996) made a reference for the star dunes, discussed how the dune shape can change over space with the spatially changing wind environment, and argued how the different dune types might have been formed in different parts of the desert. Verstappen's (1968) suggestion that the 'seif' dunes developed from parabolic dunes has been copied by many Indian researchers to validate his hypothesis. Unfortunately, the longitudinal dunes in our desert are not the seif dunes; the dunes occur in strong unidirectional windfield. Kar (1987, 1990, 1993b) discussed how the longitudinal dunes in the Thar differ from seif dunes and how a spatially changing wind environment can and has led to the development of linear and parabolic dunes in the same period. Linear dune formation under a unidirectional windfield and with partial vegetation cover is almost the same in other deserts (Pye and Tsoar, 1990; Tseo, 1993). The authors have not taken note of these researches. Very recently, Kar et al. (1996) measured the detailed configuration of a typical parabolic dune, using a Global Positioning System (GPS). It has revealed that about 36 per cent of the dune's total sand volume is contained in its crestal and upper mid-slope parts. This is the zone of net sand deposition. Even if an attempt is made to cut through the dune's nose, the eroded sand will be dropped in front of the earlier nose, either as another curved segment, or as low linear arms of another new parabolic bedform. This is because the sand-wind stream between the constricted corridor of the two arms flow at a relatively higher speed and lower pressure, but once the parcel is out of the constricted corridor, the surrounding air pressure will compel the speed to significantly decelerate and drop the load (Bernoulli's law). Several parabolic dunes in Jalor area, from where some examples were quoted by Verstappen, have advancing linear arms of the parabolic dunes and new noses at a considerably lower height, thus misleading the researchers.

3. Following GSI records, the authors have mapped the dunes in Churu-Sikar area as reticulate, transverse and longitudinal. While low longitudinal dunes (streaks) do exist in the area, the majority of the older ones are the transitional parabolic dunes in a network or reticulate fashion, where the transversals are usually an integral part of the system. In most cases the transitional parabolic dune here is in the form of a compound hook that is misinterpreted as a linear dune. The left arm is most prominent, but the right arm is either ill-formed, or is missing, and is replaced by a field of low transverse dunes. Some typical examples were shown in Kar (1993a). These and

many other patterns need detailed studies for an understanding of their formation mechanism and environment.

Sundaram et al. will, in all probability, hold to their views. One does not wish to lock horns with them on any of these issues, nor does one expect a sharp rejoinder for argument's sake. It is, however, hoped that the readers will view aeolian bedform research in proper perspective. Our understanding of the aeolian processes and bedforms are still very imperfect, but the directions must not be clouded.

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BOOK REVIEWS

HYDROGEOLOGICAL ATLAS OF ORISSA, (1995), Government of India, Central Groundwater Board, Southeastern Region, Bhubaneshwar.

The principal objective of a service organization like the Central Groundwater Board (CGWB) is to provide geoscientific information, maps and other data to support the development and management of the Nation's groundwater resources. We are glad that the Board is bringing out Hydrogeological Atlases of the different States of the Indian Union.

Geological and hydrogeological maps are the foundation for gaining an understanding of our land, mineral and water resources. They summarize a wealth of information gathered by a large number of scientists and make it available for user agencies. All such attempts at providing information of value should therefore be welcomed. We trust the Central Groundwater Board will accelerate the process of providing more and more hydrogeological information in graphic form in the years to come. The availability of maps is sure to revive interest in the development