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Investigating the link between genetic characteristics and mineralogy of sand dunes in Tasouki-rigchah (Southeastern Sistan)

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ABSTRACT

Arid and semi-arid regions of the planet sit in 20 to 45 northern and southern latitudes and are called the global erosion belt. Identification of these regions is thought of as the basic and rational initiation. Tasouki-Rigchah with an area in excess of 131660 hectares expands in the southeastern part of Sistan province with a harsh and dry climate. In this region, sand blasts and mobile sand dunes are threatening and dry spells and following decrease in vegetation cover and drying out of Hamoun lake, along with the winds named One-Hundred-and-Twenty-Days, lay the ground ready for wind erosion and sand blasts. In response, different wind erosion forms like Barchans and Barchanoids have been formed. Studies include speculating local evidences of wind erosion, interpretation of satellite and airborne imageries for different temporal steps, general morphological characteristics of dunes, identification of sand dune types, probing erosive wind attributes, sampling from different faeces and granolometric, morphoscopic and mineralogical analysis. Results obtained from granolometric analysis were used to identify wind speed threshold for erosion. This study set out with the aim of assessing geo-morphological faeces with underlying information obtained through sampling and granolometric analysis.

Keywords: sand dunes, Tasouki-Rigchah, sedimentology, Barchans

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INTRODUCTION

Currently thirteen million hectares of sand sheet cover a large part of Iran from which five million hectares is active and spark sand blasts, socio-economic, industrial and environmental havocs [1]. Sistan as an alluvial plateau and being evolved from deltaic sediments of the river Hirmand is confronted with a harsh and inhospitable climate and different natural and un-natural calamities. Lack of precipitation, noticeable difference between diurnal and nocturnal lowest and highest temperatures, severe evaporation, salinity and alkalinity of enclosed lands, defenseless soil to erosive winds, and occurrence of erosive winds well above threshold velocity are among pertinent physical appearances of this region which get in the way of local people to have a normal life style. Manifestation of severe droughts in very past years has added up to the acuteness of limiting factors for local people's wellbeing and has caused a myriad of vicissitudes which by the way of illustration one could point out to the hygienic problems, economic depressions like imposed damages to agricultural and horticultural crops, burial of villages and loss of fertile soils and environmental implications (Nouri, 1384). Generally, these cases were investigated:

a) Morphoscopic analysis of particles making up the samples and interpretation of sediment deposition: in this case, after preparation of granulometried samples, a part of the samples comprised of hard and stable minerals like quartz with a diameter by upward of 250 microns was separated and was investigated for roundness, corrugation, erosion manifestations, brightness or opacity under binocular.

b) Assessment of the relationship between genetic characteristics of sand dunes and other faeces: in this step, samples with diameter greater than 250 microns were analyzed for microscopic, macroscopic and mineralogical qualities for particles smaller than 64 microns by the means of X-Ray Diffrentiation (XRD).

MATERIALS AND METHODS

After the interpretation of satellite and airborne imageries and being coupled with field observatories, geo-morphological units, types and faeces were detected and in each one, detachment areas were identified and separated and the end results were mapped. Identification in each faeces was carried out using GPS and with the aid of soft wares like ILWIS, Arc Gis and ArcView. For sampling purposes, the erg was initially gridded into seven parts in length and three parts in width and this step was augmented with sampling from down parts upward to the detachment areas in the erg (three samples in each sand dune namely upwind, downwind and the crest of the dunes which later were mixed). In this process, sampling was included three samples in each dune with two-kilometer distance intervals from the depth of five centimeters of the uppermost layers. In total, 21 samples from the erg and 48 samples from the faeces were gathered. The samples in weigh of 500 grams were shaked for 15 minutes (the clods were disintegrated using a hammer) and then underwent a series of analysis. The prevailing form of dunes was Barchans which denotes the unidirectional winds in the area. In this expanse, Nebkas covered with vegetation cover (see fig.1) and sand sheets meet the eye frequently. Height of these dunes may reach up to 15 meters.

Figure 1 Nebkas under evolution in Tasouki-Rigchah

Geology of the area

Sistan indentation is developed by a collection of sizable lakes being filled by the river Hirmand at its endpoint, and the resulting deltaic processes; thus, the whole area is turned into a flat plateau with outcrops of utmost height of a couple of meters. In Sistan plateau, on account of special geological conditions, namely existence of a stationary plate with a constant gradual rate of depression, hardly old sedimentary and lithological formations other than quaternaries could be noticed. Sistan plateau and its eastern edges in Afghanistan under the name of Hirmand Deltas are developed through the deposition of sediments having been transported by the river Hirmand in the very recent geological time following the Alpine Orographic Movements. Eastern perimeter of the region is covered by alluvial and flood plains and the indentations around the lakes. Sistan expanse is regarded as a simple structured region from geo-morphological perspective and is made up with the highlands of eastern edge and the valleys elongated toward the west. In middle parts, in the conglomerates, badlands are the prevailing land forms and in the east, vast alluvial plains end at the indentations around the lake Hamoon. Virtually in all parts of Sistan, a sequence of firm and soft layers mixed with sand are expanding. The underlying ground of area is comprised of a sequence of layers of sand and layers of impermeable clay. Clayey sediments and fine sand mixed up with larger sands, lay assorted and unevenly under the latter layers. Soils of perimeters of the lakes are heavy and firm and as far as one gets from the lakes, these conditions weaken. Filish sediments are the dominant formations of the area. Color Mélanges and Filish and volcanic ashes imply the collapse of continental plates.

Geo-morphological studies

A combined interpretation of satellite and airborne imageries as well as field observations makes for an identification of geo-morphological units, types and faeces which was proceeded by further partitioning the mentioned identified

regions into a different areas mainly detachment area. To do this, and knowing that homogeneity of lithological units and the lack of accuracy in satellite imageries to differentiate things by photometrical analysis, field studies came to aid in which various faeces were checked for their ground truth using GPS in the scale of 1:50000 and then mapped by means of software packages like ArcView and Ilwins.

Sedimentary formations

Sedimentary formations in this region are mainly physically-based as follow:

- Ripple marks

Ripple marks are categorized according to their morphology into symmetrical or wavy and asymmetrical or drifty. These shapes are wavy being mainly formed on even sand mounds (Collinson & Thompson, 1982). Wind and water waves are central in the development of ripple marks being generally established in deserts and on sand dunes. Size, shape and length of ripple marks depend on the wind/water velocity and intensity.

Figure 2: ripple marks of the area

Geographic location

Crisis zone of Tasouki-Rigchah in southeastern Sistan with an area of 131660 hectares is expanded between 30 00 51 to 30 37 36 N and 60 54 42 to 61 12 47 E. the average precipitation is 59.6 and the average temperature is around 22 centigrade degrees. Of the past twenty years, eleven years have been dry.

Mineralogy and assessment of genetic relationship between components of dunes

Mineralogy analysis of samples taken from detachment areas and proportioning different minerals could provide one with a body of information to further accurately identify these areas [1 and 2]. This is also helpful when it comes to identify the origin of sediments whether they are local are flown from a way far sources (Motamed, 1376). Ahmadi 1375 and Trikar 1969 argue that distant origin sediments are lacking in fragile minerals as mica, calcite, gypsum and even feldspars while locals do have these minerals. What's more, local sediments contain a higher level of heavy minerals when juxtaposing with distant ones which is another identifier for considering a sediment mass for being local. Motamed (1376) believe that existence of feldspars, amphiboles, mica, granite and so forth are likely to make a useful means to originate sediments and identify their parent materials. Most of quartz and feldspars at a size of a sand grain are inherently taken away from volcanic and metamorphic rocks and quartz and orthoclase are specially found in granite rocks. This is while these are not found in inner felsic volcanic rocks as gabbro. Metamorphic rocks like gneiss and magmatite are important sources for quartz and feldspars too. Given that Sistan plateau from wind erosion severity perspective could be taken as the most awkward center in Iran and given that wind is almost only means of erosion in this region, and considering extensive damages being imposed on infrastructures and the implications on biological, social, economic and agricultural resources, there is an urgent need to devise a method to investigate and quantify wind erosion. Finally should be stated that prior to take any action, comprehensive and scientific assessments have to be taken. To this end, IRIFR model which comes with a great background and support from connoisseurs, is a beneficial and helpful way to approximate and quantify wind erosion. To perform mineralogy studies, binocular with the magnification of 660 times, in Karaj Natural Resources College Soil Laboratory, was used. More on that, samples were analyzed twice prior and after being rinsed with water. The

analysis were performed on random 100 quartz taken form each sample grains to investigate different forms of erosion (i.e. mechanical, water and wind)

RESULTS

Table 1 Minerals existing in sediment samples taken from the region

Type and percentage											No
Number	Orthoclase	Clay	Obsidian	Ortose	Muscovite	Gypsum	Calcite	Chlorite	Biotite	Quartz	Sample
95	4	2	1	5	4	2	8	1	3	65	1
99	5	5	4	4	2	1	8	3	4	63	2
97	0	4	3	5	5	4	5	0	1	70	3
98	2	4	5	3	0	3	9	0	2	70	4
94	2	3	4	5	1	5	11	1	8	54	5
98	0	5	3	5	0	8	7	0	5	65	6
91	0	8	0	2	7	2	8	1	3	60	7
96	0	3	4	4	0	5	9	2	4	65	8
97	1	8	2	2	0	3	9	0	2	70	9
92	2	5	2	5	4	3	7	0	4	60	10
94	0	4	5	3	1	2	8	2	4	65	11

Table 2 Morphoscopic analysis of stable minerals (quartz)

Morphoscopic analysis of quartz for its roundness and type of erosion					
Circumstances	Roundness	Opacity	Transparency and aureole	Crustiness	Sample
Erosion affected	Semi-round	76	13	1	1-wind
Erosion affected	Semi-angular	69	18	3	2-wind
Erosion affected	Semi-angular	58	41	1	3-wind
Erosion affected	Semi-angular	62	34	4	4-wind
Erosion affected	Semi-angular	61	38	1	5-wind
Erosion affected	Semi-angular	58	42	0	4-wind
Erosion affected	Semi-angular	43	54	3	7-river
Erosion affected	Semi-round	72	27	1	8-wind
Erosion affected	Semi-angular	34	64	2	9-river
Erosion affected	Semi-angular	54	43	3	10-wind
Erosion affected	Semi-angular	52	47	1	11-wind

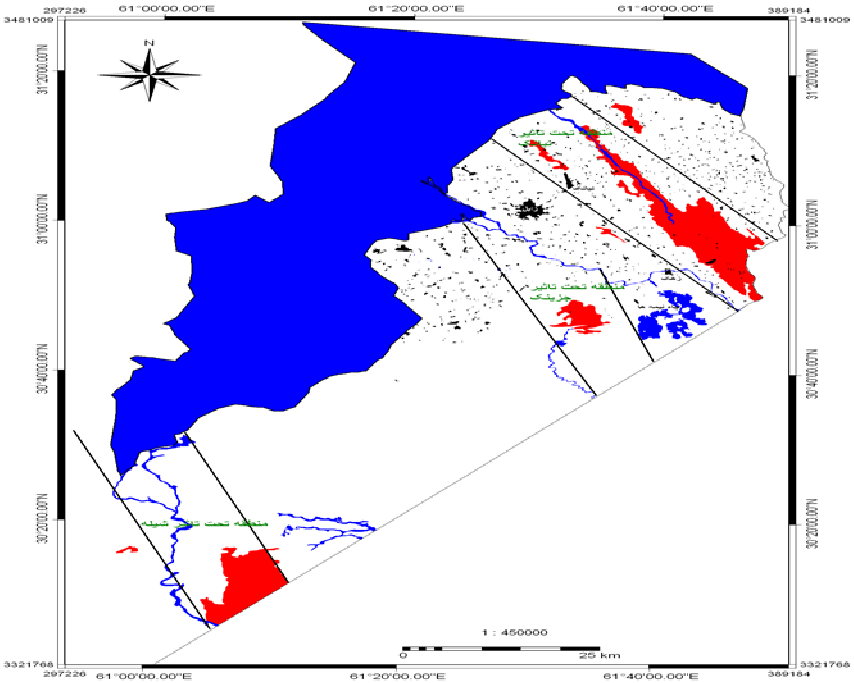

Figure 2: Location of critical wind erosion centers in Sistan plateau

Area of study

The region is under severe atmospheric currents which the discharge of energy manifest itself through hurricanes and sand storms. Mobility of sand deposits and the following rush toward housings, farms and vegetation cover is a widespread concern. Temperature distribution over the region sparks local winds with carious directions with low velocity. Another type of wind; which is called frontal; forms as the result of zonal tunnels. The principle form of wind in the area is called one-hundred-and-twenty-day-wind that is the main cause of sand blasts over the region. Figure one illustrate the critical wind erosion centers in Sistan plateau.

DISCUSSION

Importance of work

Knowing dynamic and trajectory of mobile sands is important for assessing the past and the future trends. As major part of mobile sand dynamic, one could point out to the identification of origin (Mohs, 1995). Locating sand deposits' origin and drawing genetic relationships shows its importance when human's housing, industry, agriculture and even life are under threat. Beside, stabilized deposits today could turn into source of sediment in the future considering climate change in the twenty first century and more on that, stabilizing sediment deposits doesn't prevent the entrance of more sediment into the region (Mohs, 1995).

CONCLUSION

Research shows that local deposits turn mobile when a gale-force wind starts blowing. Most minerals of the region are made up of chlorite, illite and montmorillonite. Sediments present in Zabol-Zahedan didn't use to exist and the reason for their existence stems from the drying out of the lake Hamoun. Important sedimentary forms of the area are: ripple marks, encroachment of sand, sand feeds, sand indentations. Different origins for the sediment of the region cause the existence of grains in different sizes. The main sand dunes are comprised of barchans which denotes the one-way direction of the local winds. Besides, nebkas and sand sheets meet the eye frequently.

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