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Microtextures on quartz grains in the Estuary sediments of Gurupura River, Dakshina Kannada district, Karnataka State, West coast, India.

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Abstract;

The present study focuses on the surface textures of the quartz grains derived from the granitic rocks in a fluvial regime on the west coast of India. The surface microtextures formed during transport due to their stable physical and chemical properties. The surface textures include information about source rock types, transporting force, sedimentary environment and evolution history of the sediment. For this purpose, eight samples were collected and investigated from the Gurupura River estuary of Dakshina Kannada District of Karnataka state west coast in India. The quartz grains show distinct surface textures with unique mechanical, chemical and morphological features. The mechanical features such as conchoidal fractures with arcuate steps indicate that the sand grains were derived from crystalline source rock (i.e., granite) and transported in a high-energy condition. The silica globule, overgrowth, and precipitation marks on the grain surfaces suggest action of chemical processes in a saturated silica environment, which is evident in the upper reaches of the Gurupura River. Surface textures of the quartz grains along the lower reaches of the Gurupura River display an array of mechanical features like a conchoidal fracture, V-shaped marks and impact pits, indicating the impact of mechanical processes. The overall pattern of the surface textures present on the quartz grains suggests moderate to high energy conditions in the Gurupura River.

Keywords: Microtextures, Estuary Sediments, Gurupura, SEM, West coast.

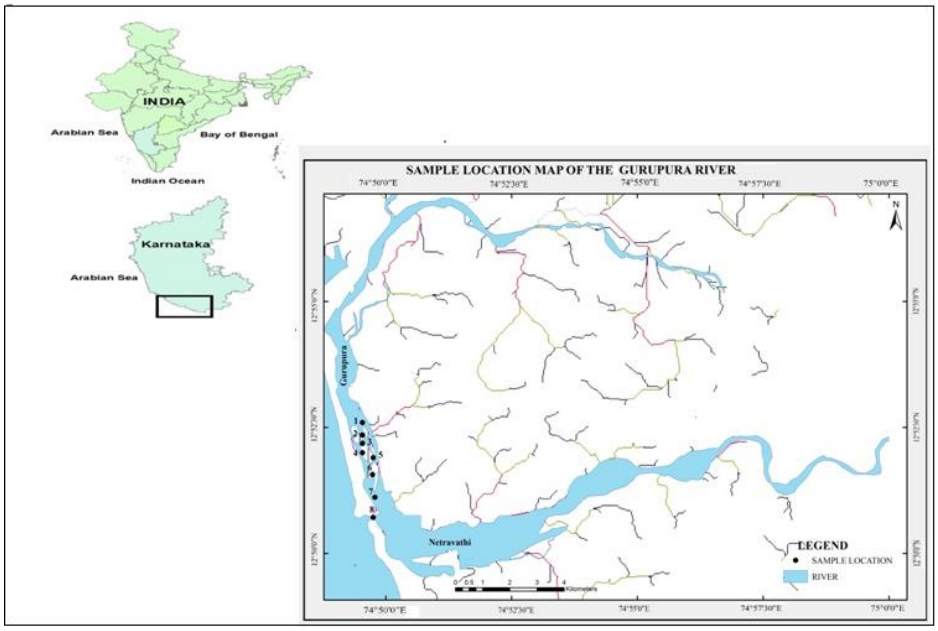
Introduction

The study of surface textures of quartz grains with the help of scanning electron microscopy (SEM) is considered a powerful tool in sedimentary petrology for interpreting sedimentary environments and the provenance of the detrital sediments (Madhavaraju et al., 2006; Armstrong et al., 2014). Furthermore, the surface textures provide useful information regarding the various processes acting on the grains during transportation (Chakroun et al., 2009). Different impact features and the abrasion marks on the quartz grains are formed during transport in various dynamic environments, and they generally record those processes. Based on the variety of surface textures observed on the quartz grains it is possible to distinguish the particular depositional environment such as marine, fluvial, aeolian and glacial (Madhavaraju et al., 2006). The purpose of the present study is to study the surface textures present on quartz grains in the Gurupura River sediments exclusively derived from peninsular gneiss on the west coast of India.

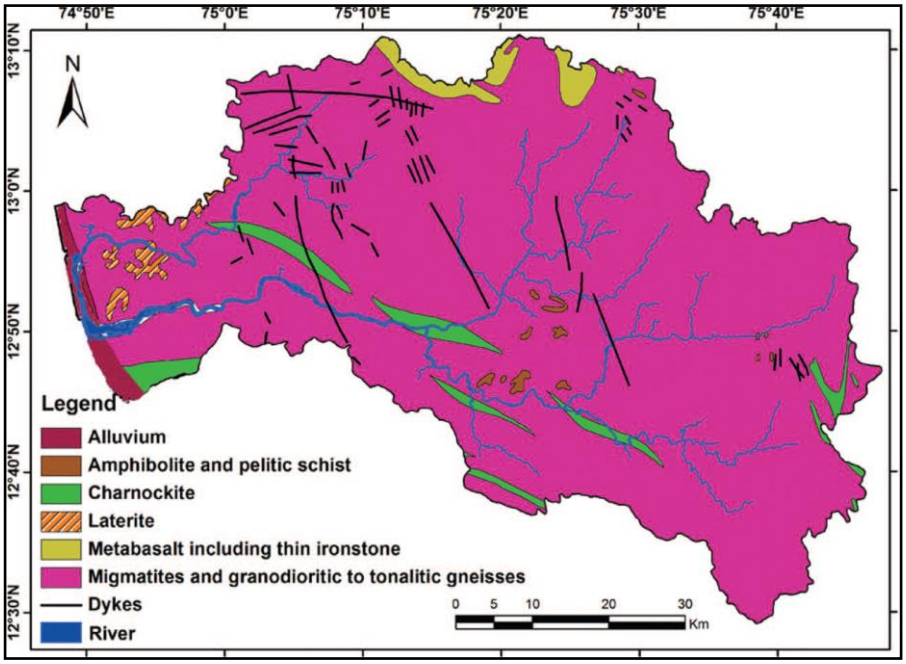
Investigated Area

Dakshina Kannada is a three coastal district located in the southern and coastal part of Karnataka adjoining the Arabian Sea. The geographically entire district spreads over 4770 sq. km. The study area lies between lat. 12˚ 50’00’’& 12˚55’00’’N and long. 74˚ 50’ 00’’& 75˚00’00’’ East.

The Geological map of the area (Map.2) indicates that the N–G River basins are covered by Pliocene to Recent laterite capped plateaus and alluvium over the gneisses and continental type of sedimentary deposits with dolerite and norite dikes (Geological Survey of India 1981, Radhakrishna and Vaidyanadhan 1994). The Gurpura river is tectonically active due to a number of seismically active faults/ lineaments and its proximity to Mulki–Pulicat lake axis (a straight line close to 13^0 N connecting the west and east coasts of India). The slight deviation of the drainage divide from this fault can be ascribed to differential headward erosion of the north-easterly and south-easterly flowing rivers (Subrahmanya 1994). The N–G river channels consist of cobble–pebble–gravel at their upper reaches and coarse sand in their middle parts (for~ 50 km). The river basins consist of migmatites and, granodioritic to tonalitic gneisses of the Peninsular Gneissic Complex with enclaves of high-grade supracrustals (Geological Survey of India 1981, Nair 1990).



Map.1. Location and sample points of the study area, Geology of the Netravathi and Gurupura River Basin



Map. 2 Geological Map of the Netravathi and Gurpura river basins (source: Geological Survey of India 1981).

Materials and Method

Sand samples were collected from the eight locations of the Gurupura River estuary. Samples were collected at 200-300 meters regular intervals along the 2-3 km length during the Post-monsoon season (Month of February 2020) (Map.1). For the microtextural study. Approximately 100g of each sample was socked with H_2O_2 and HCl to remove the organic matter and carbonate coatings from the quartz grains and then washed several times with distilled water (Krinsley and Doornkamp, 1973; Helland and Holmes, 1997). The treated samples were sieved to separate the sand-size fraction. The samples were sieved at 0.6-Ø interval by using the ASTM sieve setson Ro-tap mechanical sieve shaker. Sand grains of 120 ASTM size were used for the surface microtextural studies. Fot the study of variability present in the grains (Higgs 1979; Krinsley and Doornkamp, 1973), 3-4 selected quartz grains in each sample were selected. Quartz grains were examined for their surface microtextural features in *Hitachi S-3400N SEM at a magnification of ×5 to ×300,000* at the Department of Material science, Vijnana Bhavan, University of Mysore, Karnataka, India.

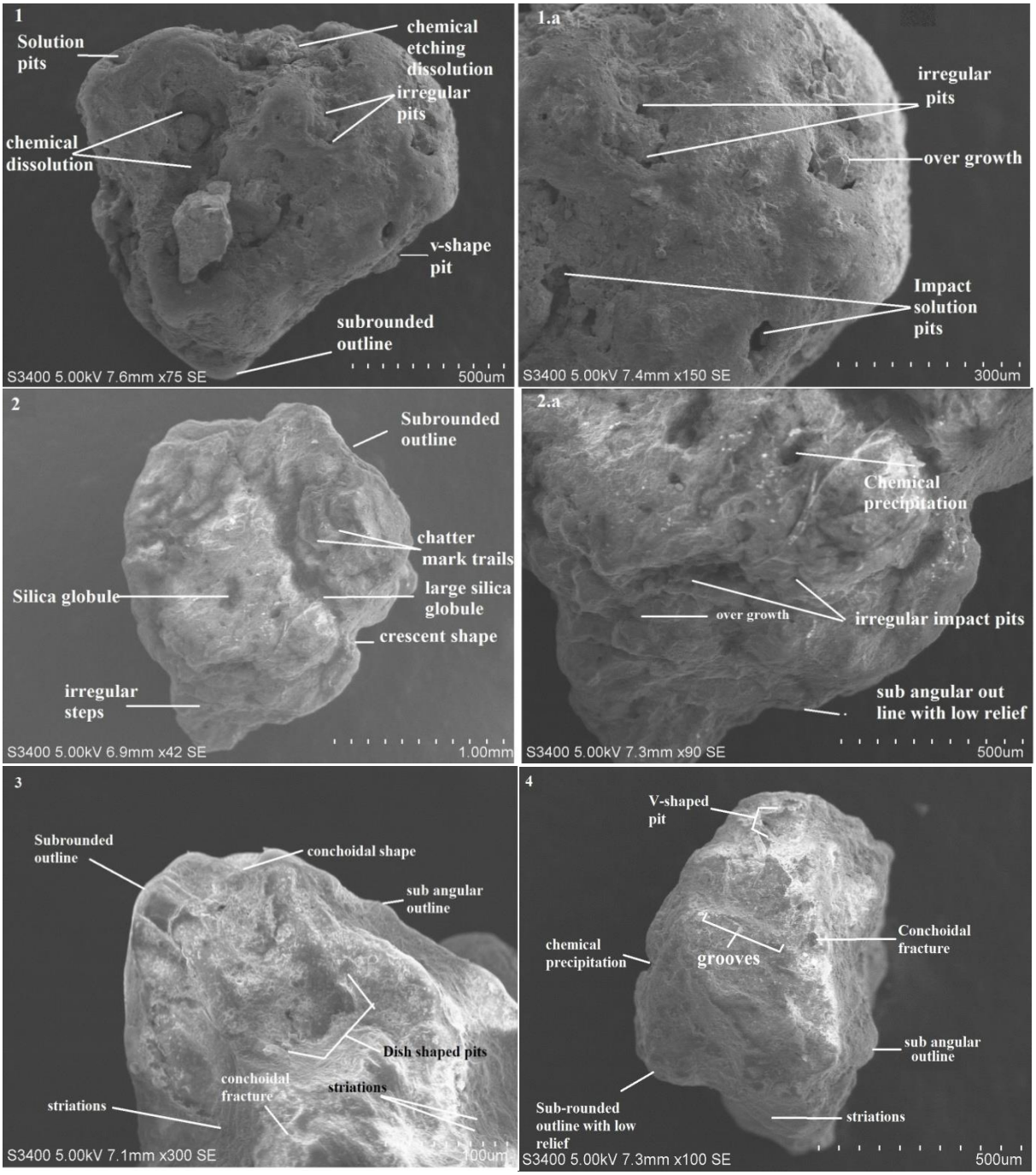


Plate-1 Microtextures observed on quartz grains form Gurupura estuary (Samples: 1–4) S-1: Quartz grain showing solution pit, chemical etching dissolution, irregular pits, V- shaped pit, sub rounded outline and chemical dissolution.S-1a: Irregular pits, over growth, impact solution pits.S-2: Sub rounded outline, chatter mark trails, silica globule, large silica globule, cresent shape, irregular steps. S-2a: Chemical precipitation, over growth, irregular impact pits, sub angular out line with low relief. S-3: Sub rounded outline, conchoidal fracture, dish shaped pits. S-4: V-shaped pit, chemical precipitation, grooves, conchoidal fracture, sub angular outline, striations, sub rounded out line with low relief.

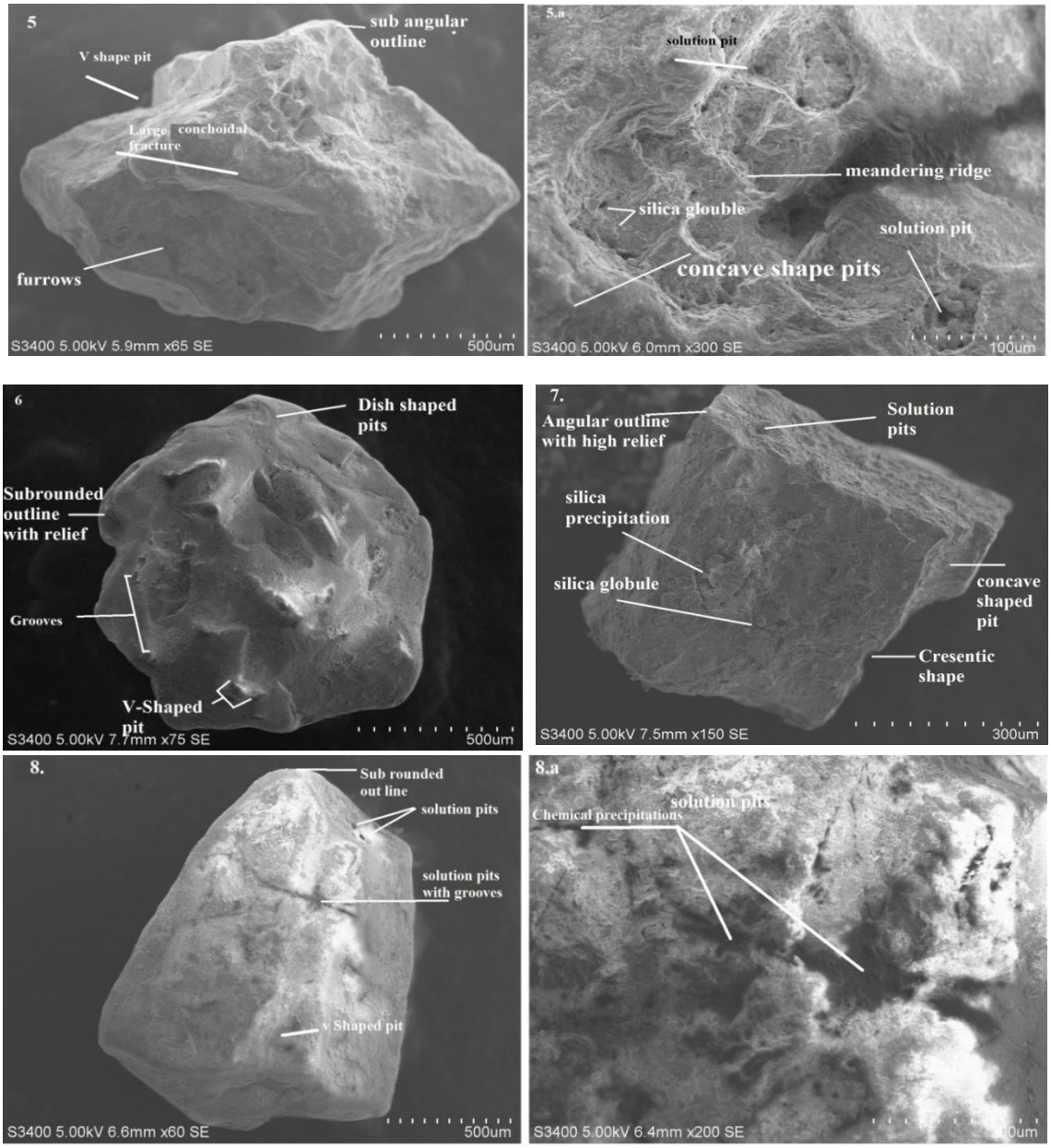


Plate-2 Microtextures observed on quartz grains form Gurupura estuary (Samples: 5-7) S-5: V-shaped pits, large conchoidal fracture, furrows, sub angular outline. S-5a: Solution pits meandering ridge, silica globule, concave shape pits steps. S-6: Dish shaped pits, sub rounded outline with low relief, Grooves, V- shaped pit. S-7: Angular outline with high relief, solution pits, silica precipitation, silica globule, concave shaped pits, cresentic shape S-8: Sub rounded outline, solution pits, solution pits with grooves, V- shaped pit. S-8a: Chemical precipitations, solution pits.

Fig.1 Number of Various types of Microtextures on Quartz grain

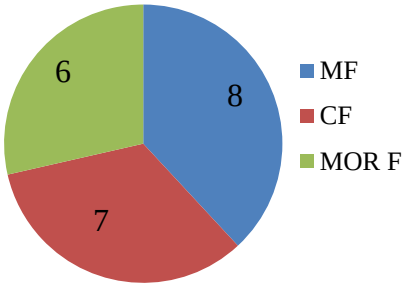


Fig.2 Mechanical microtexture features on quartz grain

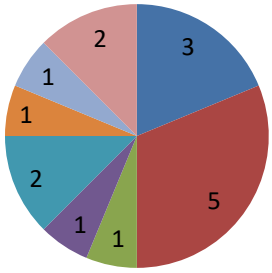
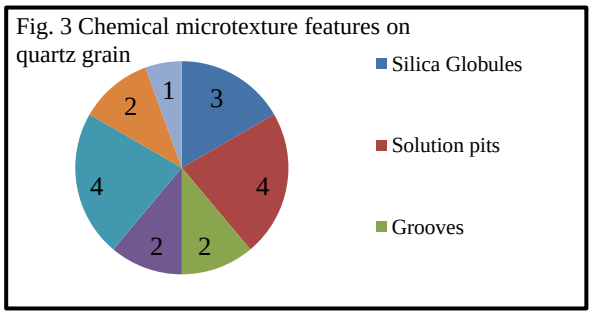
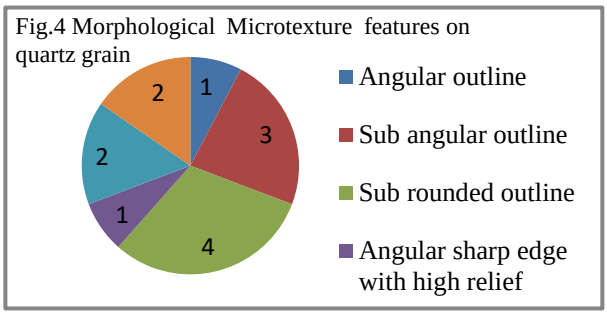


Table.1 Frequency of Quartz surface microtextural features in Gurupura River Estuary

Surface microtextural features	Sample numbers							
	1	2	3	4	5	6	7	8
Mechanical features								
Concoidal fracture	-	-	P	P	P	-	-	-
V-shaped pits	P	-	-	P	P	P		P
Meandering ridges	-	-	-	-	P	-		-
Dish shaped pit	-	-	-	-	-	P	-	-
Concave shaped pits	-	-	-	-	P	-	P	-
Irregular impacts	-	P	-	-	-	-	-	-
Curved striation	P	-	-	-	-	-	-	-
Irregular pits	P	P	-	-	-	-	-	-
Chemical features								
Silica Globules	-	P	-	-	P	-	P	-
Solution pits	P	-	-	-	P	-	P	P
Grooves	-	-	-	P	-	P	-	-
Over growth	P	P	-	-	-	-	-	-
Chemical precipitation, (dissolution)	P	P	-	P	-	-	-	P
Impact solution pits	P	P	-	-	-	-	-	-
Chatter marks trails	-	P	-	-	-	-	-	-
Morphological features								
Angular outline	-	-	-	-	-	-	P	-
Sub angular outline	-	-	P	P	P	-	-	-
Sub rounded outline	P	P	P	-	-	-	-	P
Angular sharp edge with high relief	-	-	-	-	-	-	P	-
Sub angular outline with low relief	-	P	-	-		P	-	-
Sub rounded out line with low relief	-	-	-	P	P	-	-	-





Result and Discussion

Mechanical features

The mechanical features like conchoidal fractures, V-shaped pits, meandering ridges, Dish shaped pits, concave-shaped pits, irregular impacts, curved striations and irregular pits are recognized on the quartz grains. These features are formed during the erosion or weathering process, grain to grain abrasion and collision during transportation of sediments commenced from their source. The mechanical features like conchoidal fracture are mainly observed in samples numbers of 3, 4 and 5 and V-shaped pits are identified in samples numbers 1,4,5,6 and 8 in the middle part of the river. Meandering are ridges observed only in sample number 5, and dish-shaped pits and concave-shaped pits are observed mainly in numbers 5, 6 and 7, and irregular impacts, curved striations and irregular pits are observed in samples number 2, 1, 1 and 2, respectively. Conchoidal

fractures, arcuate and straight steps marked on quartz grains are derived from the crystalline source rocks, i.e., granite. The linear striations are mainly produced in the high- energy environment (e. g. Krinsley and Marshall, 1987). The V-shaped features and parallel orientation are formed by grain-to-grain collision during transportation (e. g. Manickam and Barbarous, 1987). The abundance and size of the V-shaped pits on the grains indicate a long duration with high intensity of subaqueous agitation (e. g. Manickam and Barbarous, 1987). (Table.1 and Fig.2)

Chemical Features

The chemical features associated with silica globules and solution pits in the grains are formed by the precipitation of silica from chemical solution due to the long residence of the sediments in the depositional basin under a saturated silica environment (Udayaganeshan et al., 2011; Armstrong-Altrin and Natalhy-Pineda, 2014). Chemical features identified are silica globules, solution pits, grooves, overgrowth, chemical precipitation, impact solution pits and chatter mark trails (Table.1 and Fig.3). Based on the mode of origin, the chemical features are classified as chemical dissolution and precipitation. The solution pits formed by the chemical dissolution of sand grains are observed in samples numbers 1, 5, 7 and 8; silica globules are chemical precipitation origin noticed in samples numbers 2, 5 and 7 and are formed by the precipitation of silica from chemical solution due to the long residence of the sediments in the depositional basin (Udayaganeshan, et al. 2011) under silica saturated environment (Armstrong-Altrin and Natalhy-Pineda2013). Impact solution pits in sample locations 1and 2. The sands of variable grain size with circular and sub-circular (Krinsley and Doornkamp, 1973) shapes are attributed to the influence of contaminated seawater (Armstrong-Altrin and Natalhy-Pineda 2013). Chemical Precipitation features are mainly observed in sample numbers 1, 2, 4, and 8; Chetter marks trail are noticed in sample location 2. The grooves on the quartz grains are formed by a chemical process at reducing water velocity (e. g. Joshi, 2009). The low energy of the river during the low rainfall conditions is revealed by the high equency of chemical features on the quartz surface

Morphological(Mechanical/Chemical)features

The quartz grains of locations 1 to 8 showing more or less the sub angular to sub rounded outline of straight and arcuate steps suggesting that the sediments have undergone short transportation and rapid deposition. This result suggests angular outline has been gradually decreased by the action of downstream transportation and resulted in rounding of the quartz grains

River flow direction

Grab Sampler

Sample collection and packing

Sample collection from grab

Conclusion

Surface textures such as conchoidal fractures associated with arcuate step features suggest that the Gurupura River sediments were derived mainly from the crystalline source rocks. The v-shaped pits, and straight scratches indicate that the sand grains were transported in a high-energy fluvial environment during the high surface run-off conditions, especially during the monsoonal season. The surface textures such as striations and silica globules in the sediments represent the multicyclic character of varying transportation processes in the Gurupura River.

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