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Quartz Surface Microtextural Studies of Netravathi Estuary Sediments, Karnataka, India

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ABSTRACT

The Netravathi estuary sediments of Dakshina Kannada district, west cost of India is addressed for its transportation history and source rock. The quartz grains have distinct surface microtextures of mechanical, chemical and morphological features. The mechanical features like conchoidal fractures with arcuate steps indicate that the sand grains were derived from crystalline rocks. The abundance of angular grains supports that the grains were transported from a long distance by fluvial process. The silica globule, overgrowth and precipitation marks on the quartz surface results by its geological and geomorphological settings.

KEYWORDS: *Netravathi River, West coast, Quartz surface textures, Estuary sand*.

INTRODUCTION

Quartz, being a common rock-forming mineral, is resistant to weathering (Goldich 1938). The sediment grain transportation and deposition processes reflects by microtextures preserved on the Quartz surfaces (Margolis and Kennett 1971; Krinsley and Doornkamp 1973).The mechanical and chemical processes affect the sediments during the transportation (Al-Saleh and Khalaf 1982), thus modifying the grain surfaces. The quartz surface microstructure of the sand grain is reflecting the depositional environment, and differentiates the fluvial, marine, aeolian and glacial environments (Chakroun et al. 2009; Newsome and Ladd 1999). Geologically Netravathi River basin consists of gneisses, charnockites, felsic and mafic dykes, meta volcanic, meta sediments, laterites, alluvium and sand deposits of marine and fluvial origin. (CGWB, 2012)

Investigated extent

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

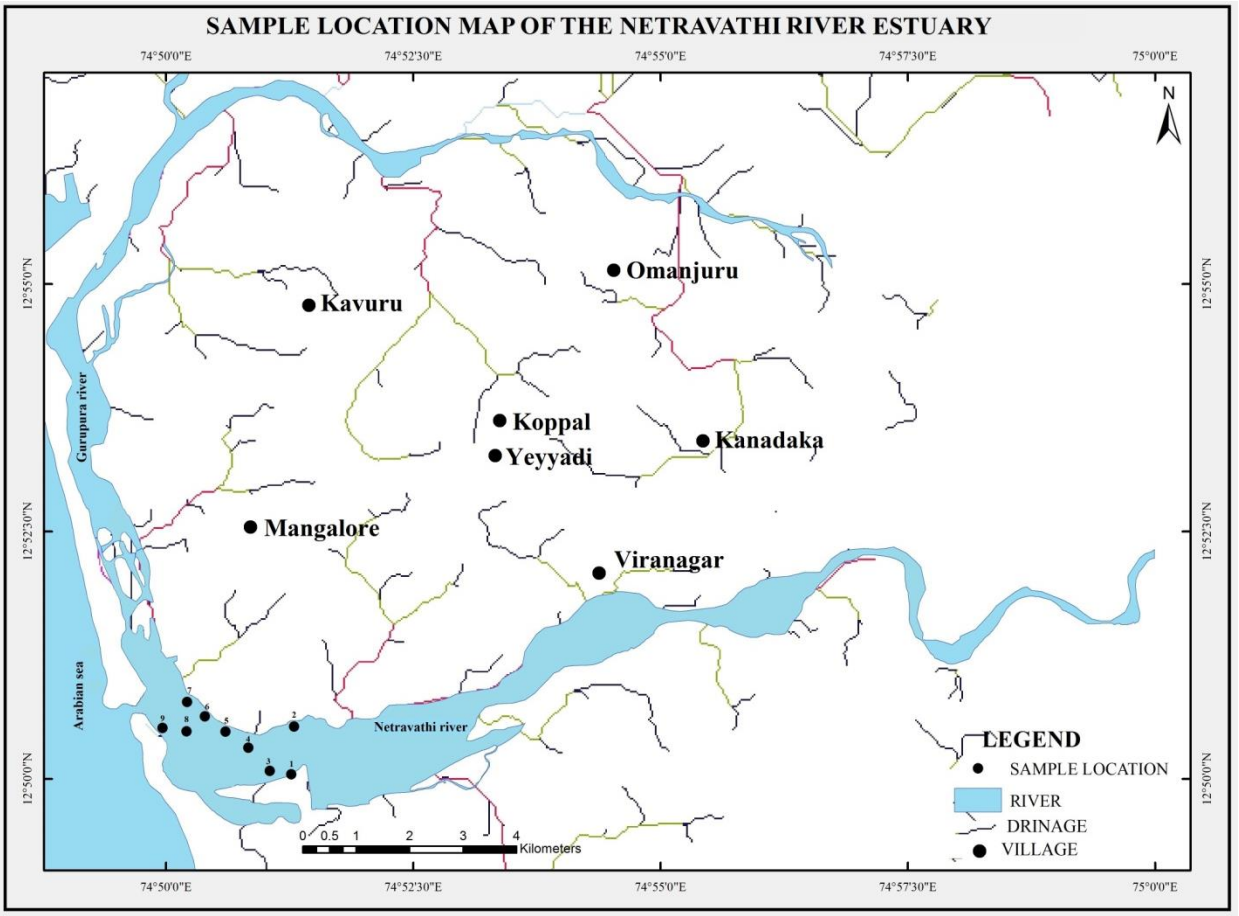

Figure 1: Location of sample points of the study area, Dakshina Kannada

MATERIALS AND METHOD

Sediment samples were collected at 0.5-km intervals along the 2-3 km length of Netravathi River estuary during the Post-monsoon (February 2020) (Figure 1). 100gm of sediments were socked with H_2O_2 and HCl to remove the organic debris and carbonate coatings, respectively. The samples were sieved at 0.6-Ø interval by using the ASTM sieve sets on Ro-tap mechanical sieve shaker. The sand grains of 120 ASTM size were used for the surface microtextural studies. To represent the variability present in a grain (Higgs 1979; Krinsley and Doornkamp, 1973), 3-4 quartz grains in each sample were studied in this work. Quartz grains were examined for their surface microtextural features in Hitachi S-3400N SEM at magnification of ×5 to ×300,000.

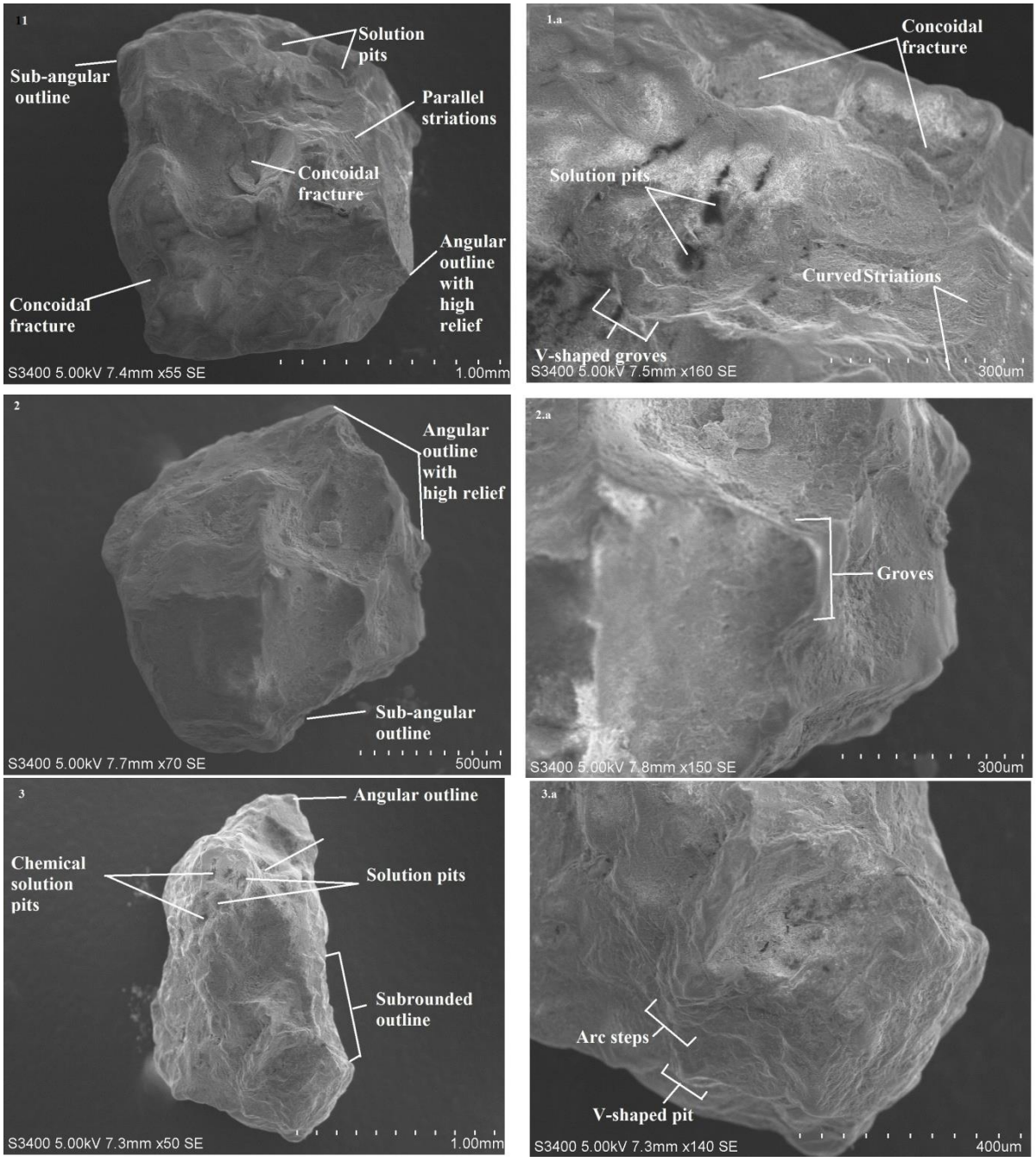

Figure 2: Surface micro textures of sand grains (locations: 1–3) S-1. Sub angular outline, solution pit, Parallel striations, conchoidal Fracture, angular out line with high relief S-1.a. curved striations, V Shaped grooves. S-2. Angular outline with high relief, Sub Angular outline. S.2.a Grooves. S-3. Chemical Solution Pit, Angular out line, Solution pit, Subrounded outline. 3a Arc step, V-shaped pit.

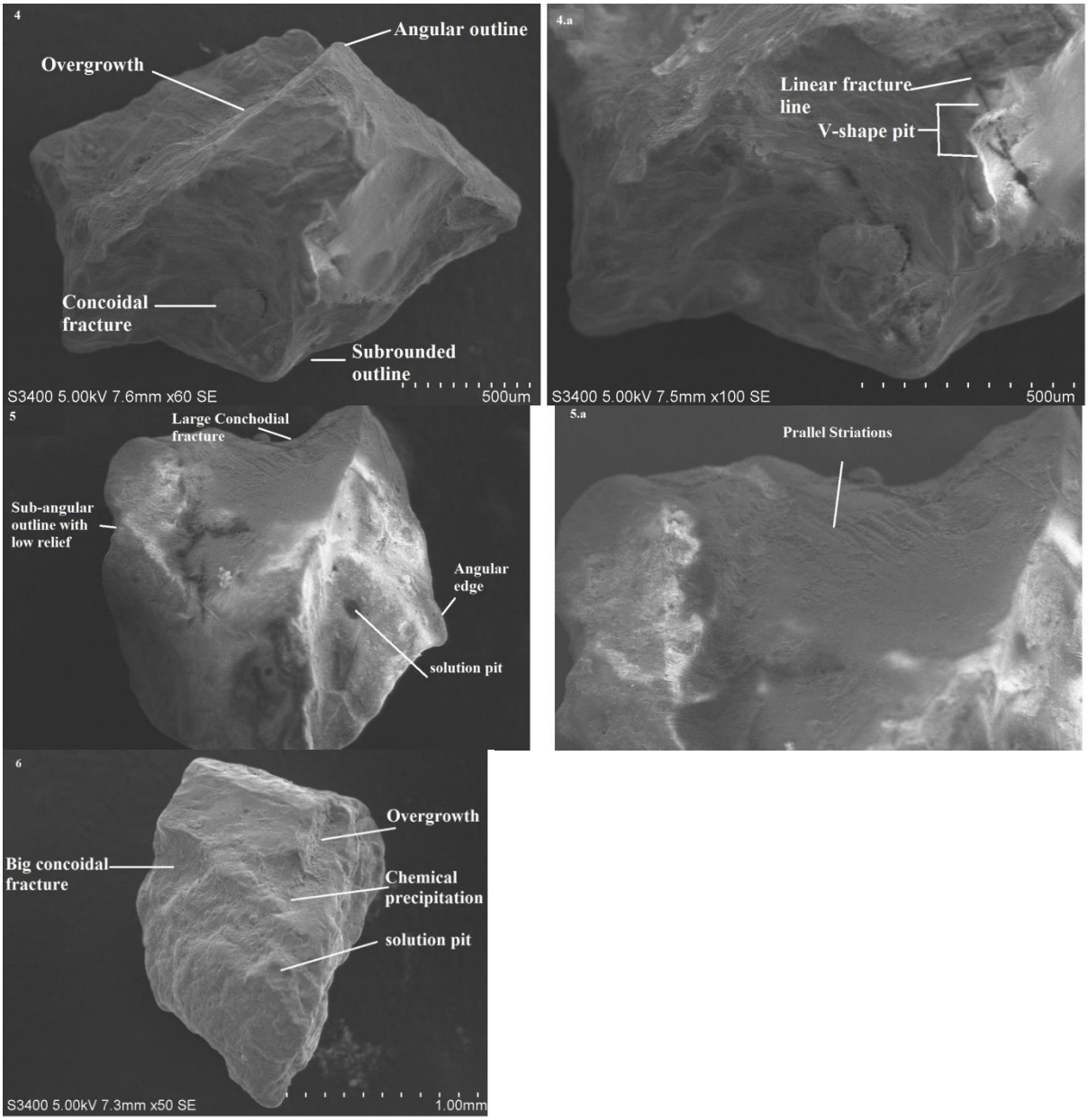

Figure 3: Surface microtextures of sand grains (Locations 4-6) S-4 Over Growth, Conchoidal Fracture, Angular outline, Sub rounded outline. S-4.a Linear Fracture line, V-Shaped pit. S-5 Large conchoidal fracture, Sub angular outline with low relief, solution pit, angular edge. S-5.a Parallel Striation. S-6 over Growth, Chemical Precipitation, solution pit, Big Conchoidal fracture.

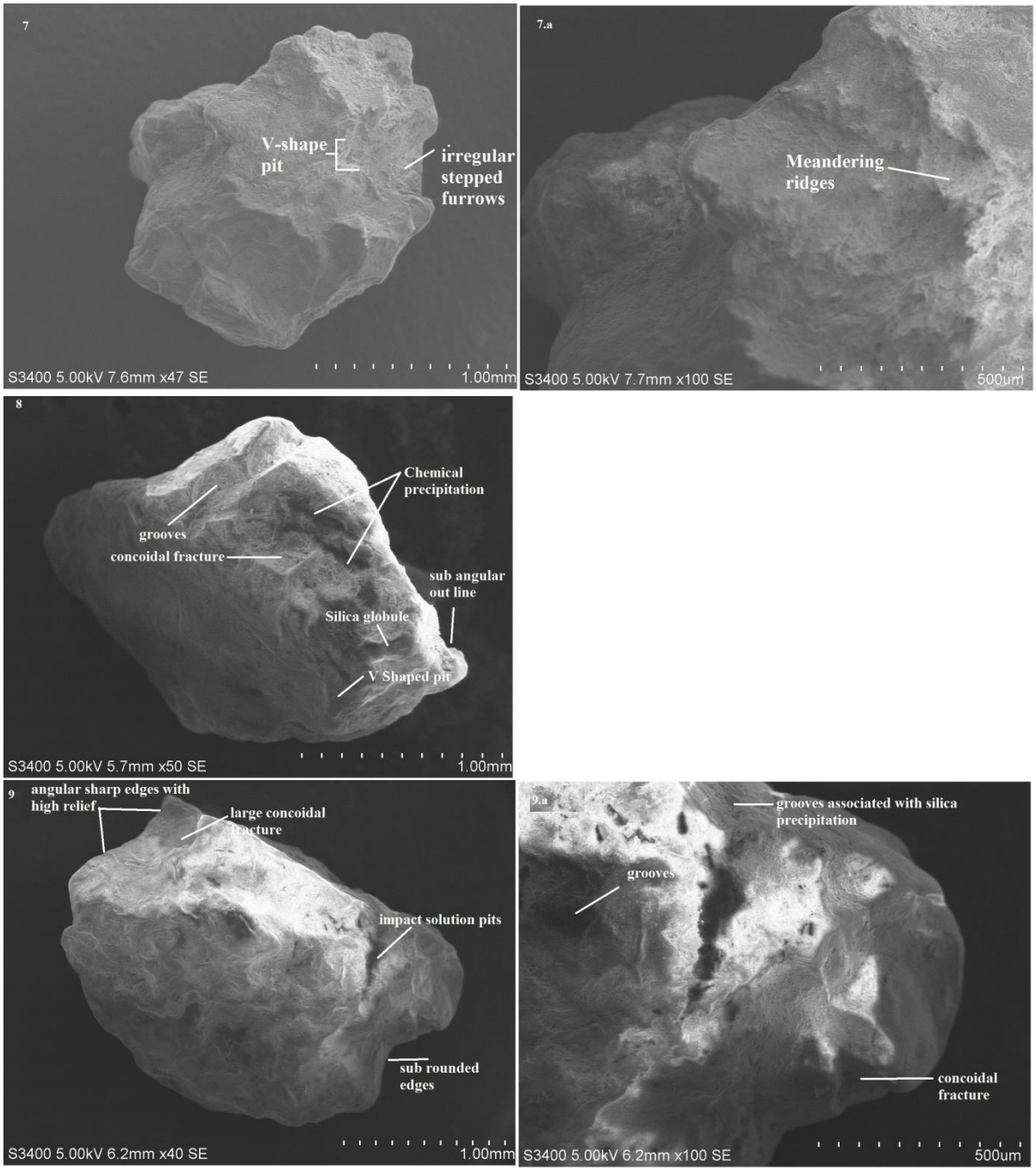

Figure 4: Surface microtextures of sand grains (Locations 7-9) S-7. V-shape Pit, Irregular Stepped furrows. S-7.a Meandering ridge. S-8. Chemical precipitation, Grooves, sub angular outline, Silica Globule, V-shaped pit, S-9 angular sharp edge with high relief, Large conchoidal fracture, impact solution pit, sub rounded edges. S-9.a Grooves, conchoidal fracture, grooves associated with silica precipitation, conchoidal fracture.

RESULT AND DISCUSSION

Mechanical features

The mechanical features like conchoidal fractures, V-shaped pits, meandering ridges, parallel straight, and V-shaped striations, linear fracture line, curved arcuate, arc-shaped and irregular-stepped furrows are recognised on the quartz surface. These features are formed during erosion or weathering process, grain to grain abrasion and collision during transportation of sediments from their source. The presence of conchoidal fractures, Parallel striation, V-shaped grooves and curved striation are well records at sample location1-8 (Figure 2-4) quartz grains, arch steps at (Figure

1) S-3 Irregular Steeped furrows and meandering ridge (Figure 4) S-7 are derived from the crystalline source rocks, particularly the straight scratches produced by the high energy environment (Krinsley and Margolis 1969, Krinsley and Doornkamp, 1973; Krinsley and Marshall1987). The V-shaped features are formed by the grain-to-grain collision (Manickam and Barbaroux, 1987), and parallel orientation of groove features might have been caused by collision between two grains (Krinsley and Donahue 1968) during transportation. The abundance and size of the V-shaped pits attribute for the long duration with high intensity of subaqueous agitation (Manickam and Barbaroux, 1987) (Table 1). These features are associated with straight and curved scratches suggesting that quartz grains are transported by the fluvial environment (Krinsley and Takahshi, 1962; Krinsley et al. 1964).

Chemical features

The chemical precipitation features are associated with silica globules in the sand (Figure 3) S-8 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). Solution pits in the (Figure 2), S-1,3 (Figure 3), S-5, 6 (Figure 4) S-9. The sands of variable grain size with a circularand sub-circular (Krinsley and Doornkamp, 1973) shape attributed to the influence of contaminated sea water (Armstrong-Altrin and Natalhy-Pineda 2013). The parallel-oriented grooves on the quartz grains of (Figure 2) S-2(Figure 4) S-8 and 9 are formed by a chemical process at reduced water velocity (Joshi 2009).Over growth (Figure 3) locations 4, 6 chemical Precipitation features at (Figure 3) S- 6and 8 , and Impact solution pits at (Figure 4) S-9 conditions and are derived from the source rock by action of weathering process (Bull 1977, Bull et al. 1980Orr and Folk 1983) (Table 1).

Morphological features

The quartz grains of (Figure 2) S 1-4showing the angular outline and sub angular outline. (Figure 4) S-8, 9 showing angular sharp edges with high relief arcuate steps suggest that the sediments have undergone short transportation and rapid deposition, as a result of which, angular outline is gradually decreased by the action of transportation resulting in downstream rounding of quartz grains (Table 1).

Table 1: Frequency of Quartz surface microstructural features in Netravathi River Estuary

Surface micro textural features	**Sample points**								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Mechanical features									
Concoidal fracture	P	-	-	P	P	P	-	P	P
V-shaped pits	P	-	-	P	P	P		P	P
Meandering ridges	-	-	-	-	-	-	P	-	-
Parallel striation	P	-	-	P	P	P	-	P	P
Arcute steps	-	-	P	-	-	-	-	-	-
Irregular stepped furrows	-	-	-	-	-	-	P	-	-
Curved striation	P	-	-	P	P	P	-	P	P
Linear Fracture line	-	-	-	P	-	-	-	-	-
Chemical features									
Silica Globules	-	-	-	-	-	-	-	P	-
Solution pits	P		P	P	P	-	-	-	P
Grooves	-	P	-	-	-	-	-	P	P
Over growth	-	-	-	P	-	P	-	-	-
Chemical precipitation	-	-	-	P	-	P	-	P	-
Impact solution pits	-	-	-	-	-	-	-	-	P

Morphological features									
Angular outline	P	-	P	P	-	-	-	-	-
Sub angular outline	P	-	-	-	P	-	-	-	-
Sub rounded outline	-	-	P	P	-	-	-	-	-
Sub angular outline	P	-	-	-	P	-	-	-	-
Angular sharp edge with high relief	-	-	-	-	-	-	-	P	P
Angular edge	-	-	-	P	P	-	-	-	-

Note P = Present

CONCLUSIONS

- Identified 8 types of mechanical, 6 types of chemical and 5 types of morphological surface micro textures in Netravathi River estuary sands.
- Conchoidal fractures associated with arcuate step feature suggest that the Netravathi River Estuary sediments were derived largely from the crystalline source rocks. V-shaped pits related with straight scratches signify that the sand grains were transported in high-energy fluvial environment.
- V-shaped pits, arcuate steps, striations and silica globule surface textures represent the multi cyclic character with varying transportation processes and provenance of Netravathi River Estuary sediments.
- The chemical features like silica precipitation and silica globule increase towards downstream direction that implies that the grains were under the silica-saturated environment.

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