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Surficial sediment data from the Shoalhaven River delta: Bed channel and adjacent beach

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ABSTRACT

Estuaries on wave-dominated coasts generally comprise three sedimentary environments: fluvial sands and gravels derived from the catchment; marine sands characteristic of the beaches and nearshore; and silts and clays that accumulate in the sheltered central basin. Estuarine transition to deltaic form occurs when geomorphological maturity is achieved during coastal evolution. Sedimentary plains become infilled and a narrow channel connects the catchment and facilitates the transport of fluvial sediments to the coast. Here, we present modern sedimentary data that supports the idea that the wave-dominated Shoalhaven system in southeastern Australia has transitioned from an estuary to delta, transporting fluvial sediments to the modern adjacent beach and contributing to coastal progradation. A total of 141 bed channel and swash zone samples were collected from the estuarine channel of the Shoalhaven River and the adjacent Comerong Island and Seven Mile Beach, respectively. Surficial sediments were subject to grain size analysis, whereas random quartz grains from selected samples were used to indicate a qualitative degree of weathering using a scan electron microscopy (SEM). Additionally, selected samples were examined for mineralogical composition using x-ray diffraction (XRD) to provide understanding of sediment transport and provenance. The dataset, one of the most comprehensive modern sedimentary coastal records in Australia, can be used to understand the sediment dynamics and support a diverse range of coastal management decisions. The experiment de-

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sign and analyses also serve as a model that can be replicated elsewhere to better understand fluvial delivery of sediments to the coast. The dataset and analyses presented here support the research article entitled “Evolution from estuary to delta: alluvial plain morphology and sedimentary characteristics of the Shoalhaven River mouth, southeastern Australia” [1], to which readers should refer to for interpretation.

Specifications table

Subject	Earth-Surface Processes
Specific subject area	Sedimentology, Coastal Geomorphology
Type of data	Table Image Figure Map
How data were acquired	A total of 141 surficial sediment samples were collected from the bed of the estuarine channel (n=123) using a square pipe dredge, and from the swash zone of the adjacent beaches (n=18) using a hand scoop. Grain size was determined by dry sieving the coarser fraction and laser scanning (Malvern Mastersizer 2000) of the finer fraction. Grainsize distribution and statistics were obtained using software GRADISTAT. Quartz grains (0.25 -0.5 mm) from 10 samples were randomly selected and analysed using a JEOL scanning electron microscope (SEM) JCM6000. Samples were gold-coated and Secondary Electron Images (SEI) were generated using a high vacuum mode and 10 kv. Mineralogy composition of 13 samples was determined using x-ray diffraction (XRD). Size fractions finer than 1 mm were ground using a Tema mill and analysed with a Phillips 1150 PW Braggs-Brentano diffractometer with CuKα radiation. Mineralogical phases were identified and quantified from the XRD data using SiroQuant^{TM} v4.
Data format	Raw Analyzed
Parameters for data collection	Surficial sediment samples were collected systematically in order to achieve an extensive spatial coverage of the estuarine channel and beach. Following grain size analyses and preliminary comparison by visual inspection, specific samples were selected for SEM and mineralogy analyses.
Description of data collection	Bed samples were collected along the estuarine channel from the proximities of the tidal limit (Burrier) to both Shoalhaven Heads and Crookhaven Heads entrances. Sample locations were approximately 1 km apart. A minimum of two samples were collected per location, one closer to the right bank and the other closer to left bank. In places where the channel width was wider than 350 m, a third sample was collected. A fourth sample was collected at two locations where the channel width was wider than 800 m. Samples were collected using a square pipe dredge in September 2013 in the upper/middle reaches, and December 2013 in the lower reaches. Beach samples were 1-km spaced and collected in the swash zone with a hand scoop in July 2014.
Data source location	Shoalhaven River, South Coast of NSW, Australia 34° 51’ 50”S 150° 36’06” E
Data accessibility	With the article
Related research article	Carvalho, R.C. And Woodroffe, C.D. 2020. Evolution from estuary to delta: alluvial plain morphology and sedimentary characteristics of the Shoalhaven River mouth, southeastern Australia. Estuarine, Coastal and Shelf Science. Under Review

Value of the data

- The dataset is one of the most comprehensive detailed open access records of estuarine and adjacent beach surficial sediment samples in Australia.
- The Shoalhaven River is historically emblematic. Pioneer works contributed to scientific knowledge of river deltas and clastic coastal depositional environments.
- The Shoalhaven system is one of the few examples in NSW which has adopted a prograding mode, as opposed to most barrier estuaries which are still infilling.
- Dataset can be used in coastal management decisions by policy makers, researchers and stakeholders to better understand sediment dynamics and budgets.
- Data and experimental design can serve as a model for understanding fluvial sediment contributions to coastal studies elsewhere.

1. Data Description

A comprehensive suite of in-channel river bed (n=123) and beach (n=18) surficial sediments was collected to characterise the modern depositional environments of the Shoalhaven River estuary and adjacent Comerong Island and Seven Mile Beach, southeastern Australia (Fig. 1).

The mean grain size in river bed (in-channel) samples ranged from 1.3 mm (very coarse sand) to 0.016 mm (medium silt) (Fig. 2a). The general pattern is characterized by a decrease in grain size from coarse sand in the upper reaches to medium sand at both Shoalhaven and Crookhaven Heads. In the upper part of the channel, very coarse sand occurs in shallow water, whereas finer fractions (medium to very fine sand) prevail in the pools. The most diverse textural part of the river is located between Pig Island and the 10 km upstream of Nowra Bridge. In this part, the river bank is composed of medium sand intercalated with finer sediments grading to medium silt. Downstream of Pig Island, medium sand prevails and the texture becomes finer near both entrances, with coarse silt just upstream of Shoalhaven Heads and fine sand adjacent to Orient Point.

Gravel fraction was found in 80 out of 123 river bed samples. Samples with gravel content above 2% occurred mostly upstream of Numbaa Island and in the Crookhaven channel (Fig. 2b). Most of the samples taken from the river bed are dominated by the sand fraction (Fig. 2c). Mud fraction was absent in 18 samples mostly located in the Crookhaven channel (Fig. 2d). Predominantly muddy samples occur locally in the river pools (deepest parts of the main channel between Pig Island and Long Reach) and in an area near Shoalhaven Heads.

Sorting, skewness and kurtosis indicate how similar the samples are to a normal probability curve and are indicative of important sedimentary processes happening especially in the lower reaches. Results of statistical parameters for most of the middle-upper reaches are complex due to the general pattern of grain size distribution, deep pools, meandering narrow channels, and mixing with material from eroding banks.

The dispersion around the average value, known as sorting varied from moderately well sorted to very poor sorted (Fig. 2e). Sediments were moderately sorted mostly along and upstream of Long Reach, in the Crookhaven channel and at Shoalhaven Heads. Poorly sorted sediments dominate most of the river bed, and very poorly sorted sediments are observed to the west of Shoalhaven Heads.

The skewness or asymmetry is determined by the relative importance of the tails of the distribution. In-channel sediments varied from coarse skewed to very fine skewed, with most of the samples considered fine skewed (Fig. 2f). Sediments with symmetrical distribution were mostly observed at Long Reach, around Pig Island, between Berrys Canal and Crookhaven Heads. Very fine skewed samples were found scattered downstream from Long Reach towards Shoalhaven Heads and also in a sample near Crookhaven Heads. Coarse skewed sediments also occurred between Berrys Canal and Crookhaven Heads.

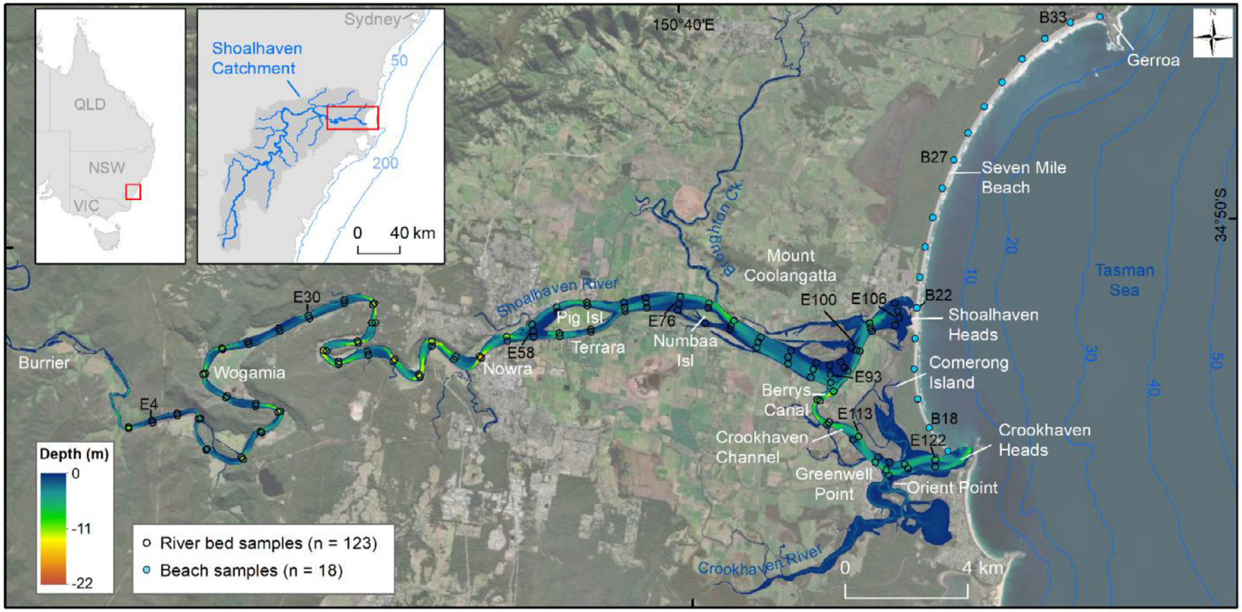

Fig. 1. River bed and beach surficial sediment sample locations. Black labels identify samples selected for further sediment analyses (XRD and SEM). Estuarine bathymetry interpolated from bathymetric data © NSW Office of Environment and Heritage (OEH) 2006. Insert maps show the location of Shoalhaven River catchment on the eastern coast of Australia.

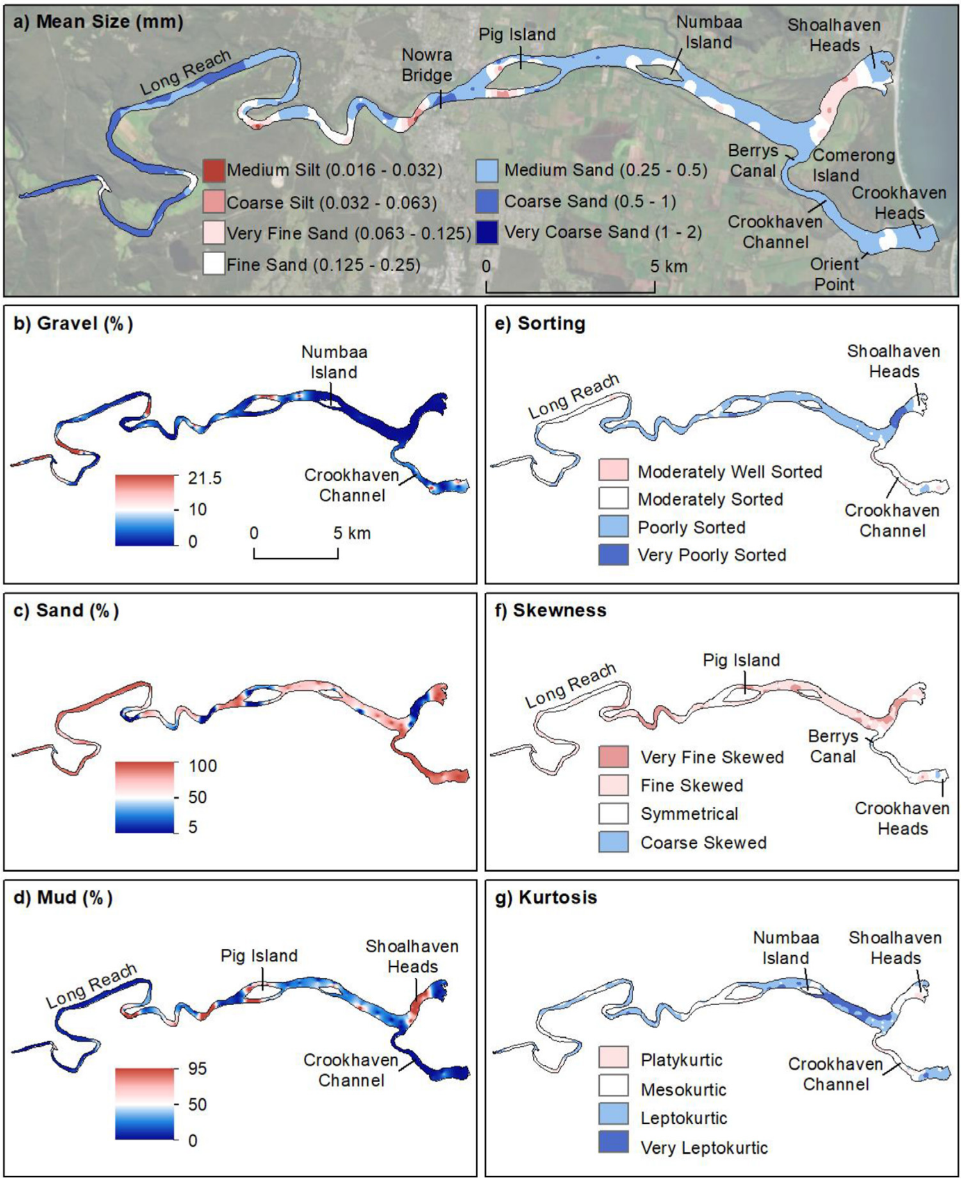

Fig. 2. Mean grain size, sorting, skewness, kurtosis and percentage of gravel, sand and mud content in river bed samples. Sand occurs along all the river bed, with coarser material further upstream and localized silt in pools and near the closed off mouth at Shoalhaven Heads. Location of samples are shown in Fig. 1.

Kurtosis measures the peakedness of the distribution. Kurtosis in the river bed sediments varied from Platykurtic (flatter than normal) to very Leptokurtic (more peaked) (Fig. 2g). 49 out of 123 samples were normal (Mesokurtic) and found in localized areas along the river channel, including near both entrances at Shoalhaven Heads and Crookhaven channel. Sediments with very peaked distribution curves (very Leptokurtic) occur especially downstream of Numbaa Island.

Table 1
Mineralogy of river bed and beach sediments (wt.%) of size fraction finer than 1 mm. Feldspars include orthoclase, albide, labradorite and microcline.

Sample	Chi square	Quartz	Feldspars	Calcite	Mg Calcite	Aragonite	Muscovite	Illite	Kaolinite
E4	2.67	82.3	14	0	0	0	0.4	2.1	1.2
E30	2.88	82	12.1	0	0	0	2.6	1.7	1.7
E58	2.36	82.1	7.7	0	0	0	5.1	3.2	1.9
E76	3.28	79.4	14.7	0	0	0	3.3	1.6	1.1
E93	2.59	82.6	9.7	0	0	0	3.8	2.7	1.3
E100	2.57	68.7	13.1	0.1	0	0.4	10.2	4.6	3
E106	3.23	89.8	8.1	0	0.2	0	0	1.5	0.5
E113	3.21	89.7	8.1	0	0	0	0	1.4	0.8
E122	2.66	92.6	5.3	0	0	0	0	1.6	0.4
B33	2.8	84.4	9	0.4	0.6	0.6	1.9	1.8	1.2
B27	2.74	88.1	8.8	0	0.1	0	0	2.4	0.5
B22	2.71	87.9	8.7	0	0.4	0	0	2.3	0.7
B18	2.98	85	9.7	0.1	0.6	0	2.2	1.6	0.8

Gravel and mud do not occur in beach samples. Beach samples were all symmetrical, mesokurtic and mostly moderately well sorted medium sand. Mean grain size ranges from 0.43 mm (medium sand) to 0.19 mm (fine sand) and decreases towards both ends of the embayment, where fine sand is observed (Fig. 3a). Well sorted sands are observed near Gerroa (at the northern end of the embayment) (Fig. 3b).

Figs. 4-11 show scanning electron microscope (SEM) images of individual quartz grains present in selected river bed and beach sediment samples, providing a qualitative perspective on degree of roundness, sphericity and chemical weathering. The roundness of quartz grains in the 0.25 – 0.5 mm fraction found in the middle of the channel, just upstream of Pig Island (E58), varied from very angular to rounded and some grains tended to have low sphericity, whereas chemical weathering could be observed on most grains (Fig. 4). Immediately upstream of Numbaa Island (E76), sediments were angular to rounded, sphericity increased and strong chemical weathering was observed on all grains (Fig. 5).

Further downstream (E93), quartz grains were also angular to rounded (Fig. 6), but angularity decreased in most of the grains and weathering attack by chemical processes was not as strong as in sample E76. The sample collected at Shoalhaven Heads (E106) was mostly composed of sub-angular grains with varying degrees of chemical weathering (from none to strong) and sphericity (from high to low) (Fig. 7). Towards Crookhaven Heads (E113), river bed grains were sub-angular to rounded, sphericity increased and no strong chemical weathering was observed on any grain. Moreover, some grains showed very little evidence of chemical weathering marks (Fig. 8). Sample E122, located at Crookhaven Heads, was composed of sub-angular to sub-rounded grains, evidence for chemical weathering was considered weak and absent in some grains (Fig. 9).

Quartz grains observed at Seven Mile Beach near Gerroa (B33) were considered angular to sub-rounded and sphericity was high in most grains. Fresh surfaces were a common feature in 6 out of the 16 analysed grains, whereas chemical weathering was observed on most of them (Fig. 10). Further south at B27, grains were mostly highly spherical and rounded to angular. Fresh surfaces were present in only a few grains, and chemical weathering was observed in most of them (Fig. 11).

At Shoalhaven Heads (B22), grains had low sphericity and were very angular to sub-angular. Some of the grains showed signs of strong chemical weathering, whereas others had fresh surfaces (Fig. 12). The grains present on the beach on Comerong Island (B18) were slightly more spherical than the ones adjacent to Shoalhaven Heads (B22), but roundness and chemical weathering were similar (Fig. 13).

Quartz (68.7-92.6%) and feldspars (5.3-14.7%) are the most abundant minerals found in bed samples (Table 1). Feldspars were observed to decrease with distance downstream. Albite and

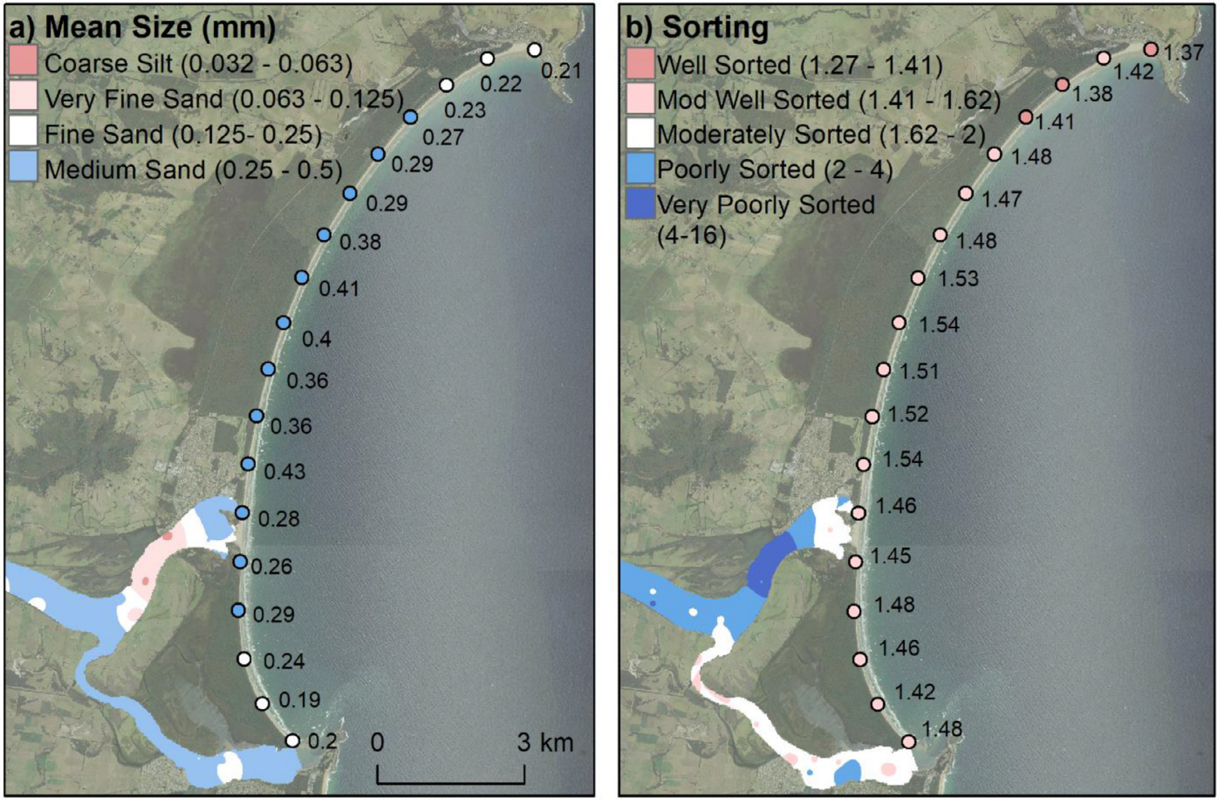

Fig. 3. Mean grain size (a) and sorting (b) in contrasting beach and lower river bed samples. Beach sands become finer and more sorted from about the river mouth at Shoalhaven Heads towards Gerroa (north) and Crookhaven Heads (south).

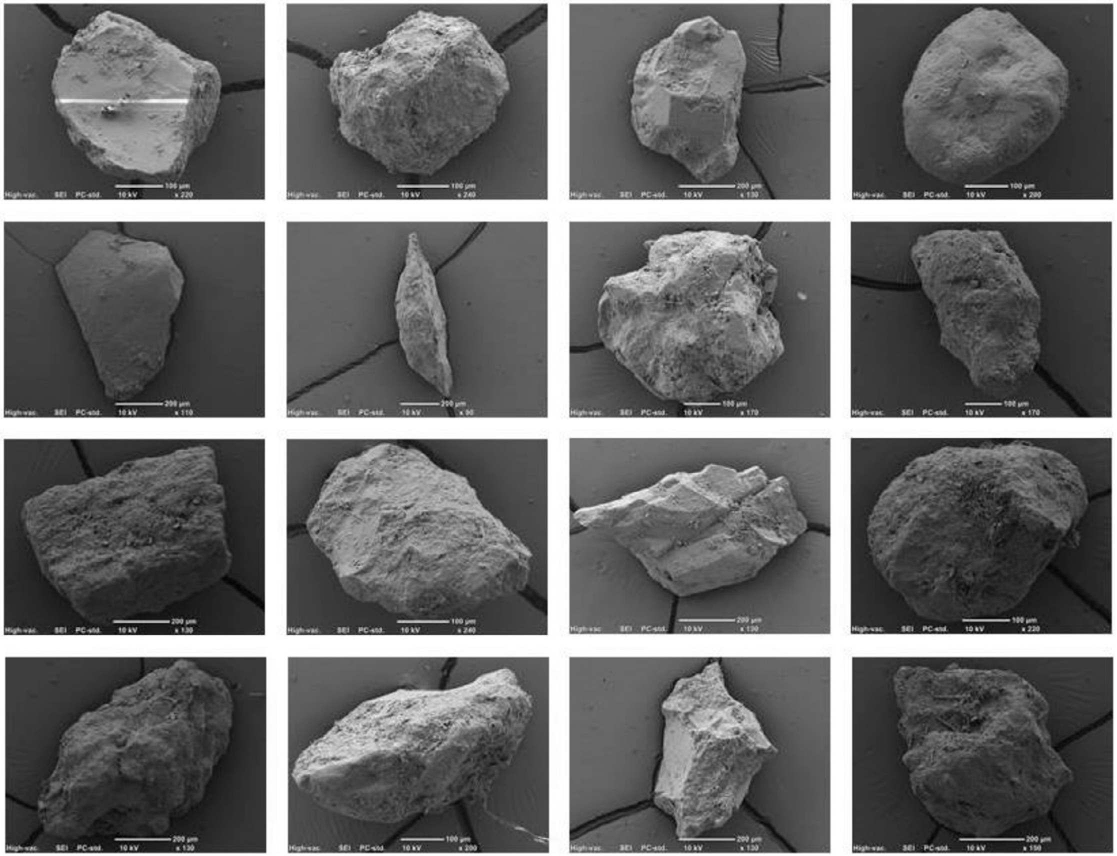

Fig. 4. SEM images of quartz grains in the 0.25 – 0.5 mm fraction in sample E58, located upstream of Pig Island. Individual grains varied from very angular to rounded and most of them were chemically weathered.

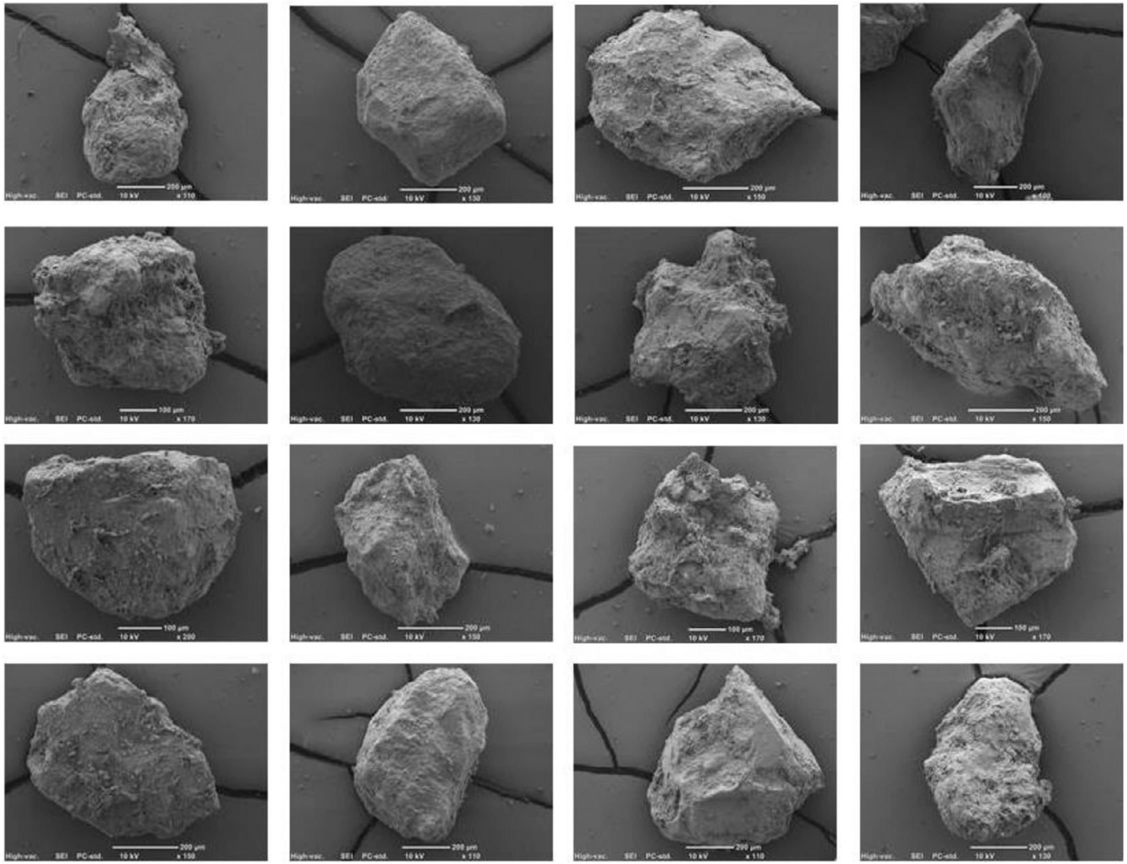

Fig. 5. SEM images of quartz grains in the 0.25 – 0.5 mm fraction in sample E76, located upstream of Numbaa Island. Individual grains varied from angular to rounded and all of them were strongly chemically weathered.

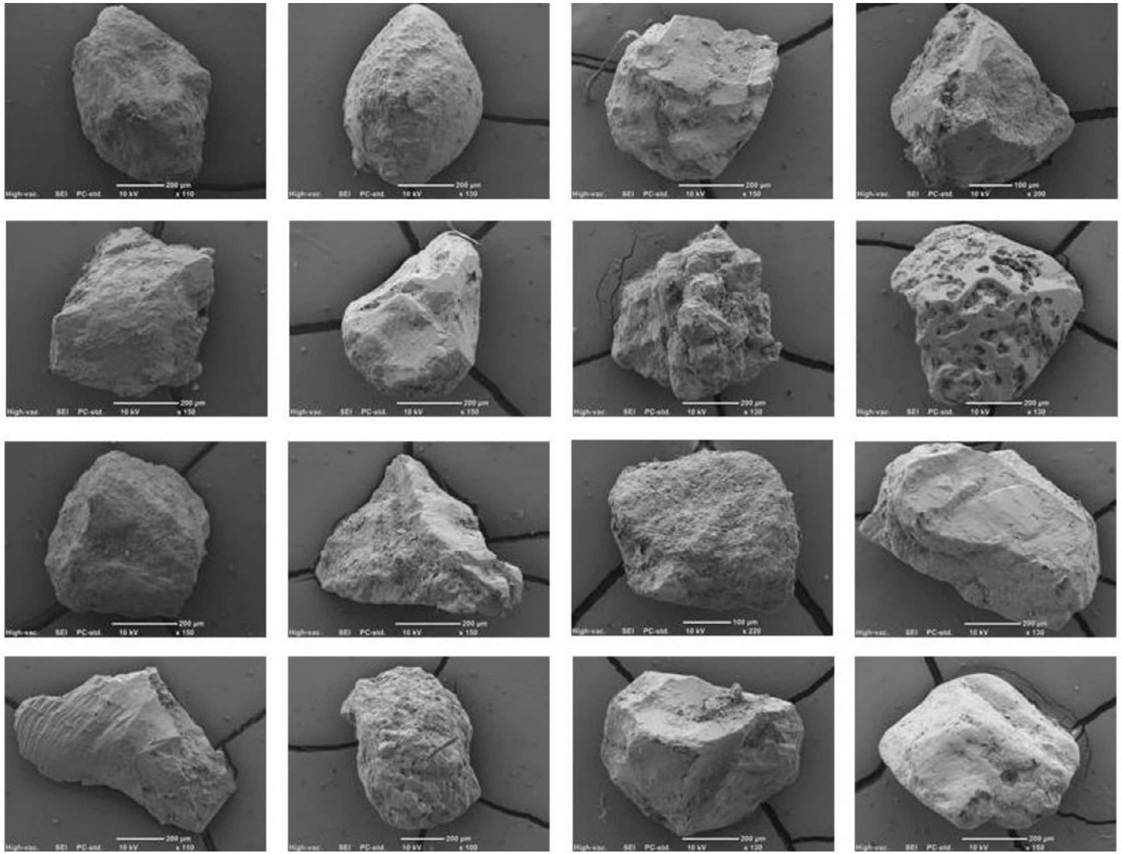

Fig. 6. SEM images of quartz grains in the 0.25 – 0.5 mm fraction in sample E93, located in front of Old Man Island. Individual grains varied from angular to rounded and all of them were chemically weathered.

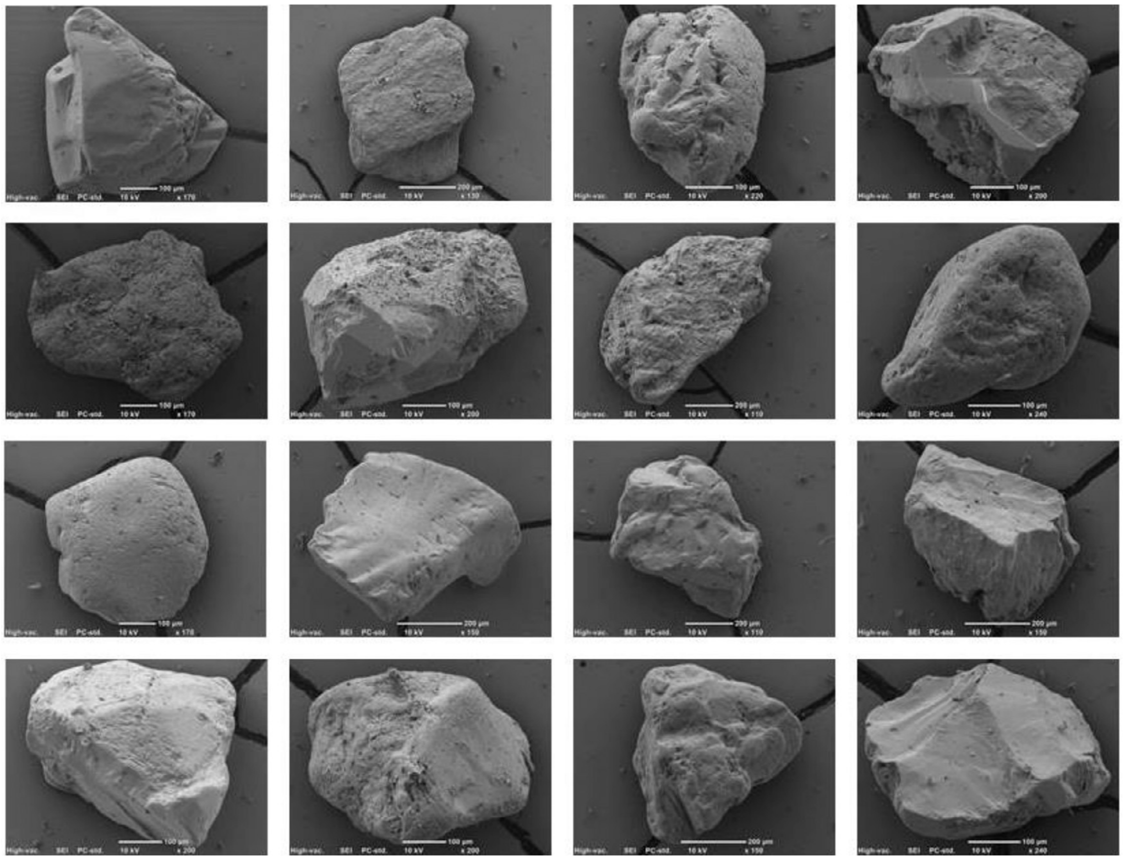

Fig. 7. SEM images of quartz grains in the 0.25 – 0.5 mm fraction in sample E106, located at Shoalhaven Heads. Individual grains were mostly sub-angular with varying degrees of chemical weathering.

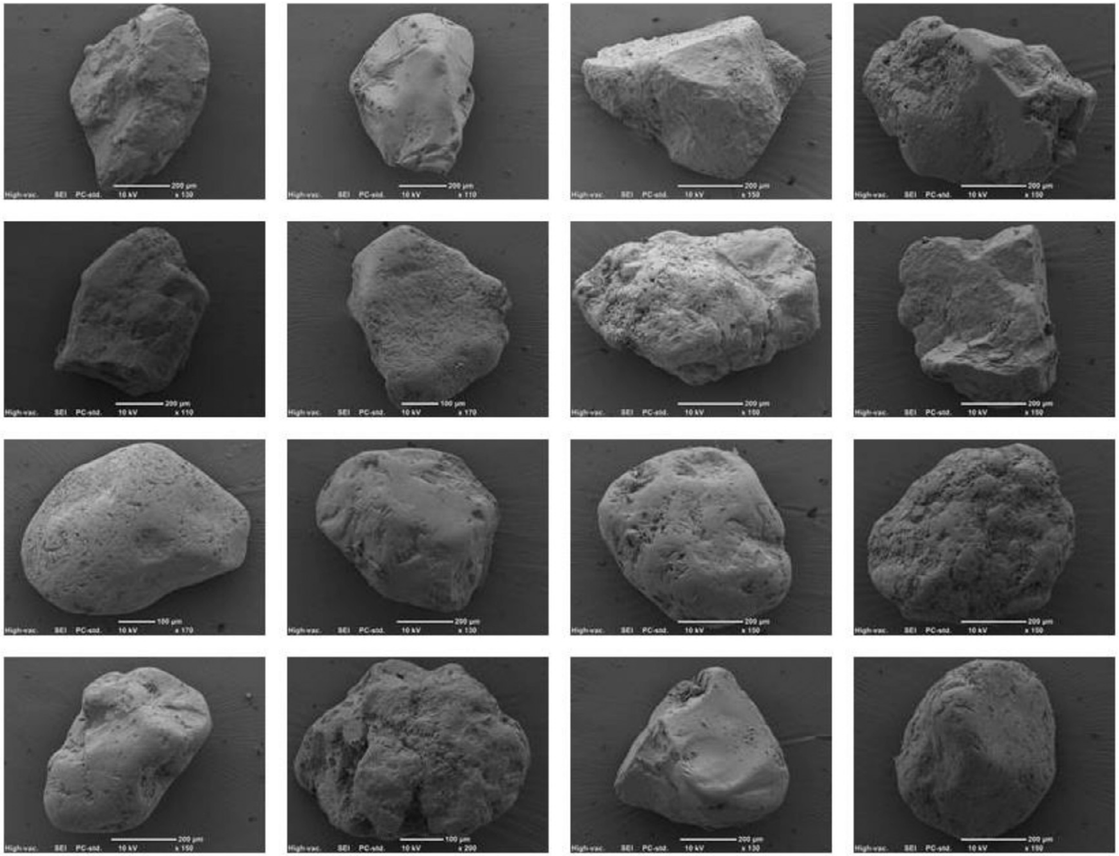

Fig. 8. SEM images of quartz grains in the 0.25 – 0.5 mm fraction in sample E113, located at the Crookhaven channel. Individual grains were sub-angular to rounded and chemical weathering was weak or absent.

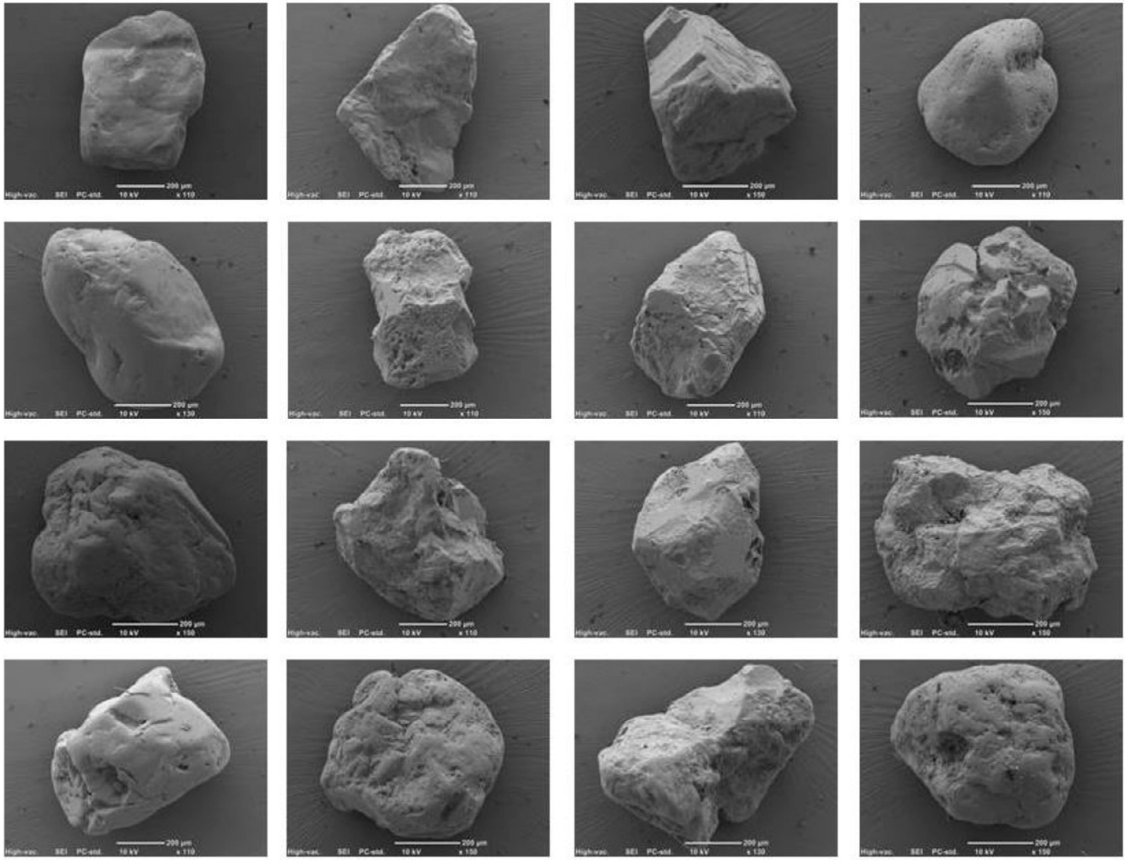

Fig. 9. SEM images of quartz grains in the 0.25 – 0.5 mm fraction in sample E122, located at Crookhaven Heads. Individual grains were sub-angular to sub-rounded and chemical weathering was weak or absent.

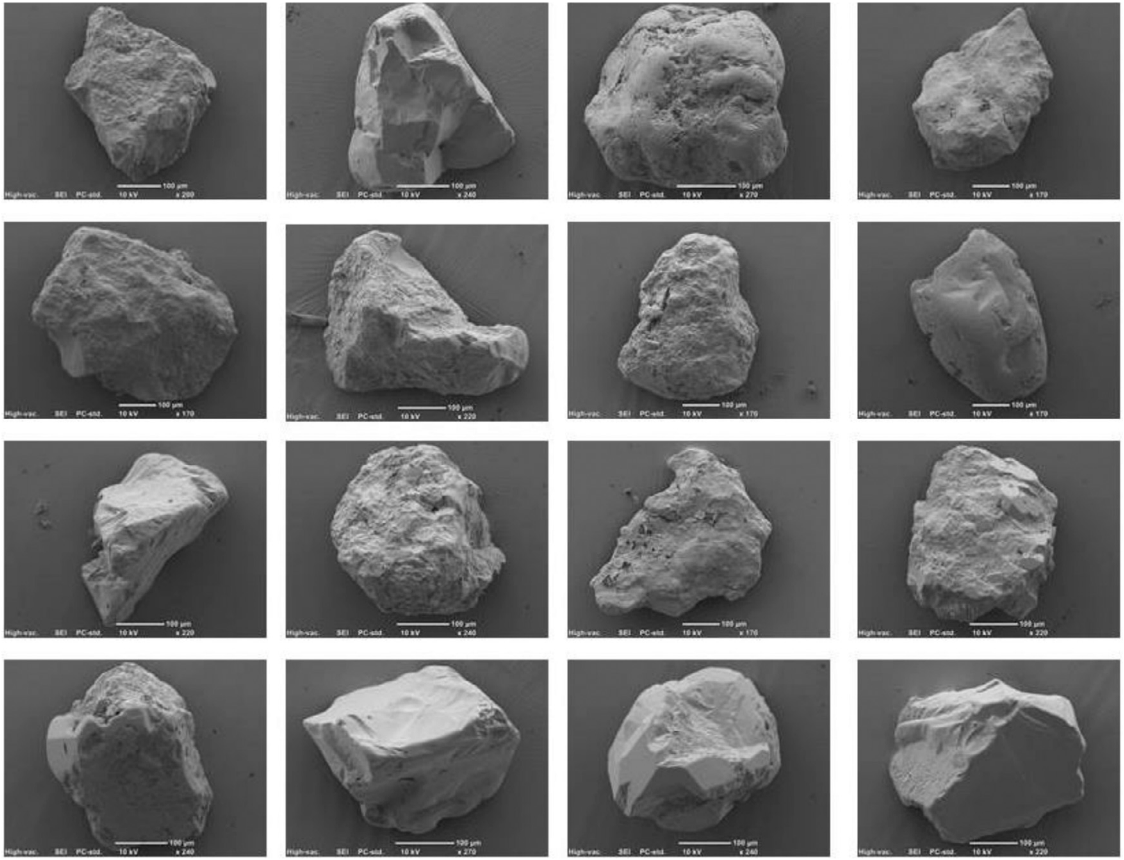

Fig. 10. SEM images of quartz grains in the 0.25 – 0.5 mm fraction in sample B33, located at Gerroa. Individual grains varied from angular to sub-rounded. Most grains were chemically weathered, whereas some had fresh surfaces.

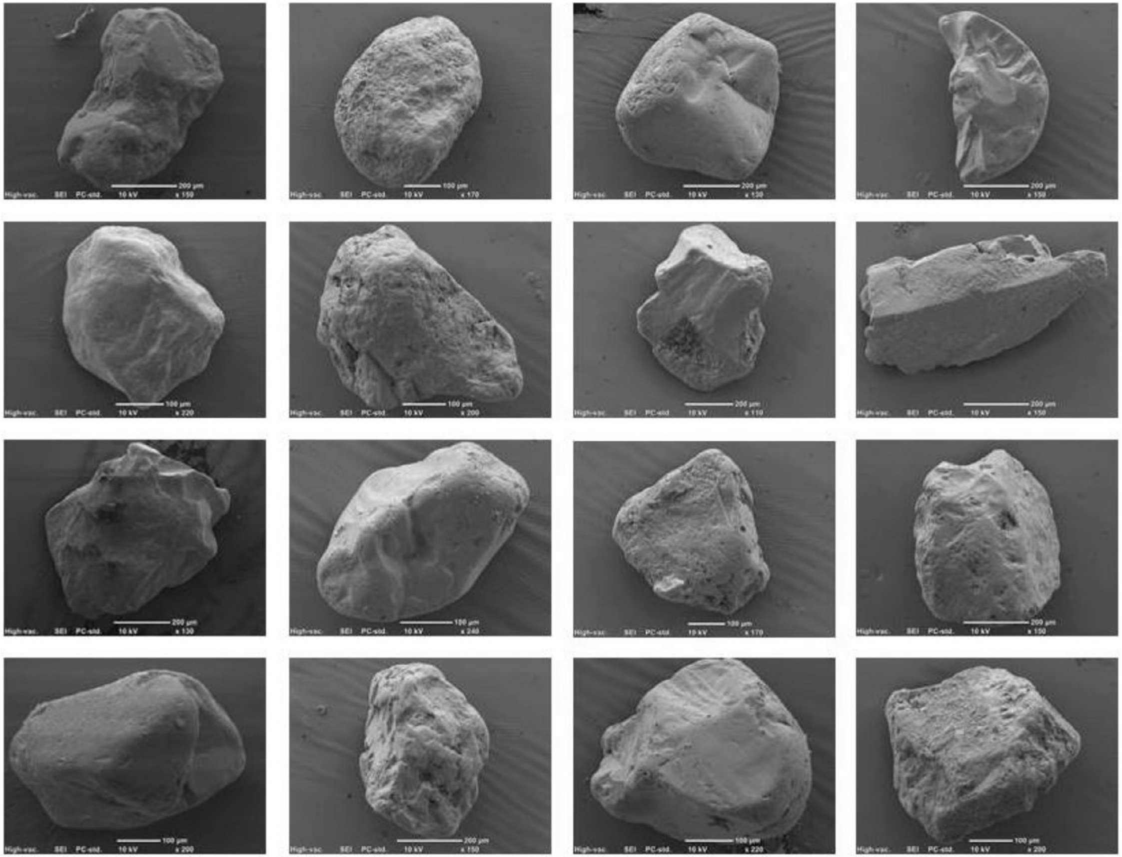

Fig. 11. SEM images of quartz grains in the 0.25 – 0.5 mm fraction in sample B27, located 5 km north of Shoalhaven Heads. Individual grains were mostly high spherical and rounded to angular. Most grains were chemically weathered, whereas some had fresh surfaces.

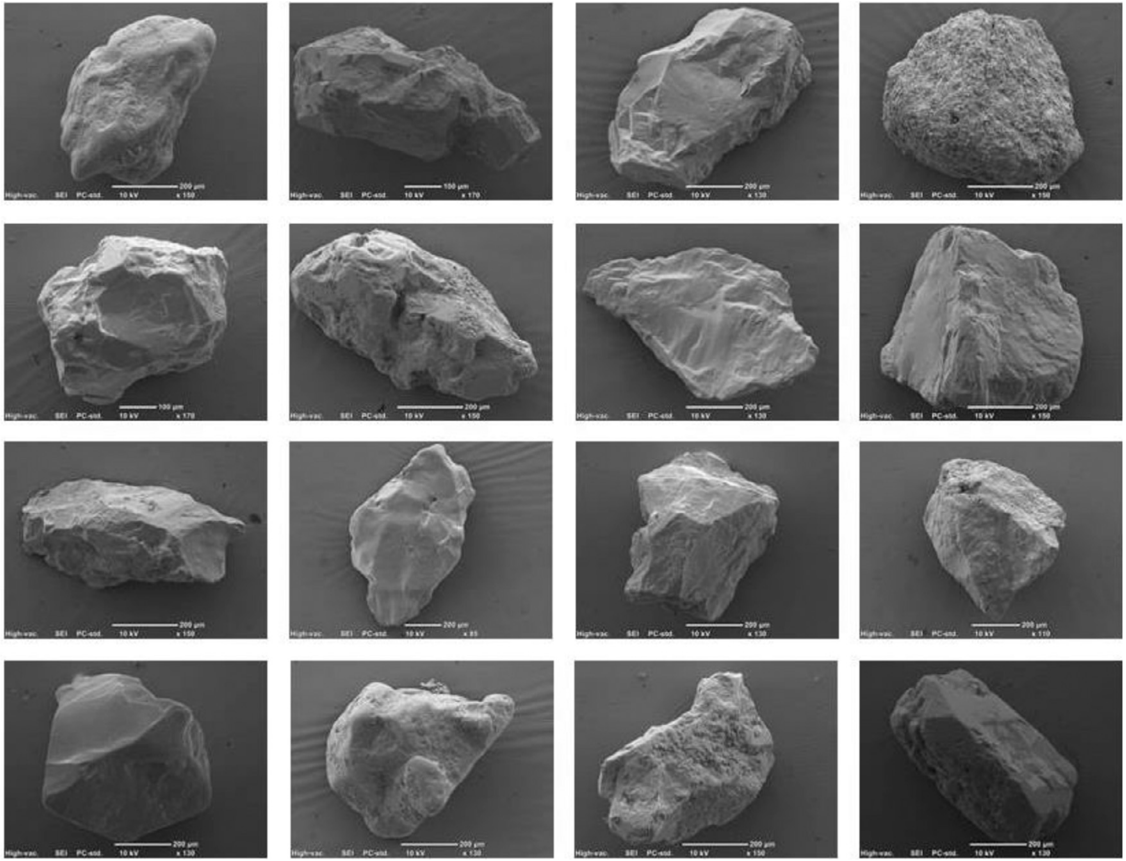

Fig. 12. SEM images of quartz grains in the 0.25 – 0.5 mm fraction in sample B22, located at Shoalhaven Heads. Individual grains had low sphericity and were very to sub-angular. Some of the grains presented signs of strong chemical weathering, whereas others had fresh surfaces.

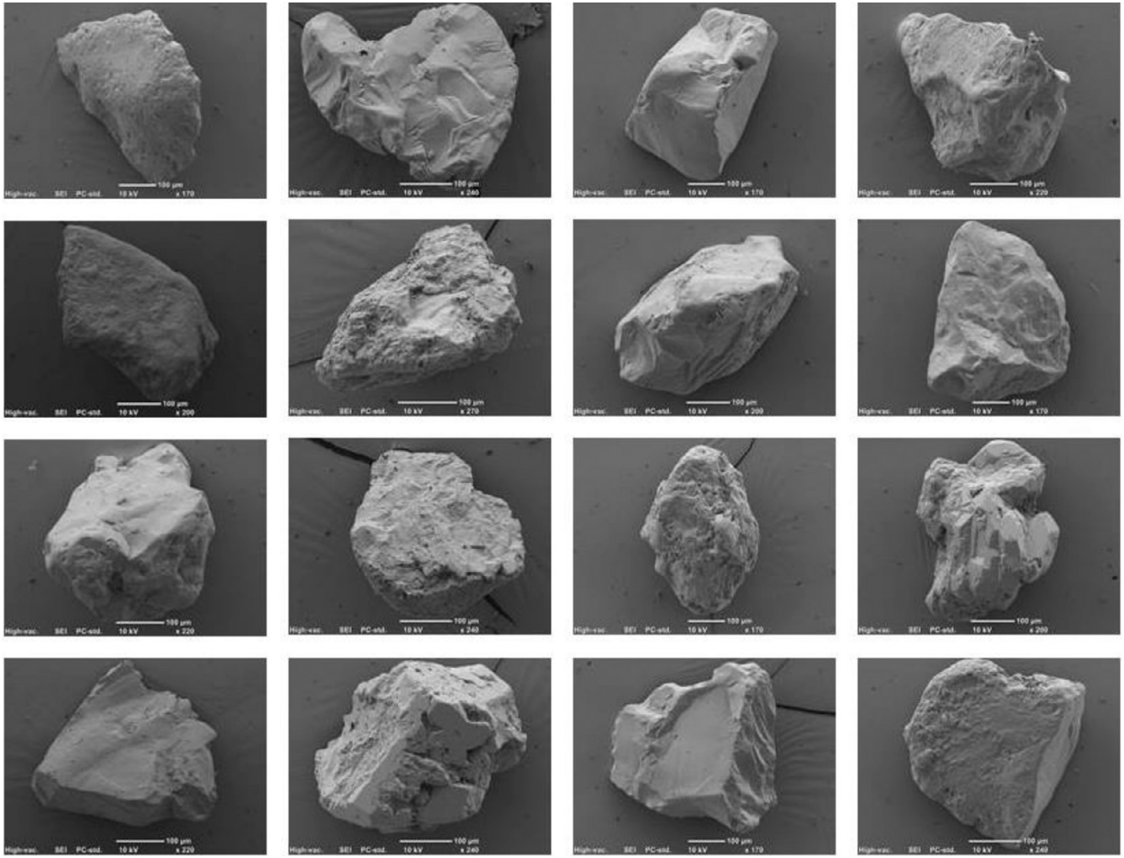

Fig. 13. SEM images of quartz grains in the 0.25 – 0.5 mm fraction in sample B18, located at Comerong Island. Individual grains were very to sub-angular. Some of the grains presented signs of strong chemical weathering, whereas others had fresh surfaces.

orthoclase were the most common forms of feldspars with concentrations of up to 5.3% and 6.1%, respectively, found in sample E4. Labradorite was present in all samples and reached its highest concentration in sample E58, whereas microcline's concentration reached 3% in sample E100, but was absent in sample E106.

Carbonates were absent, apart from 0.1% of calcite and 0.4% of aragonite found in sample E100 and 0.2% of Mg calcite found in sample E106. Clay minerals were present in the river bed samples in the form of muscovite, illite and kaolinite. Clay mineral content varied from 2% near Shoalhaven Heads (E106) and Crookhaven Heads (E122) to 18.1% along the Shoalhaven channel (E100), and showed the existence of two different surficial sediment types: the clay mineral-depleted sediments near Shoalhaven Heads (E106) and along the Crookhaven channel (E113 and E122), and the clay mineral-rich sediments upstream of Old Man Island (E4, E30, E58, E76, E93 and E100). Muscovite was absent in samples E106, E113 and E122 and very low at E4, but its concentrations were highest among the other clay minerals in the other samples, reaching 10.2% of the total weight in the very coarse silt sample E100 composed of 60% of mud fraction, and 5.1% in sample E58. Illite and kaolinite were found in all samples and their maximum concentration was 4.6% and 3%, respectively, in sample E100.

As expected, quartz, the most resistant of the common terrigenous rock-forming minerals to both chemical weathering and mechanical abrasion, is the most abundant mineral found among most of the analysed beach samples with concentrations of 84.4 - 88.1% (Table 1). Feldspars, the most abundant rock-forming minerals in the Earth's crust, were present in all samples (8.7-9.7%).

Orthoclase was the most abundant (3.7-4.2%) of the feldspars in beach samples followed by albite (1.2 – 3.9%), microcline (0.8 – 2.2%) and labradorite (0.4 – 1.6%). Carbonates were almost absent at the beach with a maximum concentration of 1.6% near Gerroa (B33). Mg calcite was the most common carbonate mineral, although calcite and aragonite were also observed at B33.

Clay minerals were present in beach samples in the form of muscovite, illite and kaolinite. Clay mineral content varied from 2.9% (B27) to 4.9% (B33). The highest content of clay minerals was associated with the decrease in mean grain size. Samples composed of fine sands, located near Gerroa (B33) and Comerong Island (B18), had approximately 2% more clay minerals than medium sand size samples B22 and B27. Muscovite was only detected in B33 (1.9%) and B18 (2.2%), where it constituted the most abundant among the clay minerals. Illite was present in all samples and was the most abundant of the clay minerals in B27 and B22. Kaolinite was also present in all samples but its concentration was lower than illite.

2. Experimental Design, Materials, and Methods

River bed samples were collected using a square pipe dredge in September 2013 in the upper/middle reaches and December 2013 in the lower reaches. Beach samples were collected in the swash zone with a hand scoop in July 2014.

In the laboratory, samples were washed for salt extraction, subsampled and dried. Approximately 150 g of sample was dry sieved using 4, 2.8, 2, 1.4 and 1 mm sieves to determine size fractions. Size fractions finer than 1 mm were determined by laser scanning using a Malvern Mastersizer 2000. Grain size statistics have been calculated using Folk and Ward [2] formulae. Individual sample results were obtained by running the grain size distribution and statistic software GRADISTAT [3]. Sample results were appended to georeferenced points, and maps of river bed surficial sediments were created by IDW interpolation. An excel file and a Google Earth KMZ file containing river bed and beach sample coordinates and all grain size parameters can be found online as supplementary data to this article.

Selected quartz grains from 6 river bed (E58, E76, E93, E106, E113 and E122) and 4 beach (B18, B22, B27 and B33) samples were analysed using the JEOL scanning electron microscope (SEM) JCM6000 (Fig. 1). 16 medium sand (0.25 -0.5 mm) grains from each sample were randomly selected using an optical microscope and placed in rows upon a metal specimen plug with double-sided sticky tape on it, and coated with gold for conductivity. Samples were analysed using a high vacuum mode with electrons accelerated to 10 kv after leaving the filament to generate Secondary Electron Images (SEI). SEM images were used to indicate a qualitative degree of roundness, sphericity and chemical weathering.

Roundness and sphericity are two properties that have significance for the study of sand transport processes, revealing modification of grains by abrasion and solution [4], as well as winnowing by currents. Roundness refers to the degree of angularity, and reflects abrasion history. Sphericity has hydraulic importance and determines how easily a grain is entrained and how fast it settles. Sphericity measures the departure of a body from equidimensionality, how close to a perfect sphere a grain is. If the three axes differ markedly in length, a particle has low sphericity. Chemical weathering is the result of chemical reaction between minerals and air or water. In quartz grains, it results in various types of etching and overgrowth features, such as solution pits and crevasses, silica globules, etc [5].

A total of 13 samples (E4, E30, E100 plus the 10 samples selected for SEM) were examined for mineralogical composition using x-ray diffraction (XRD). Size fractions finer than 1 mm were ground using a Tema mill for 60 seconds and analysed with a Phillips 1150 PW Braggs-Brentano diffractometer with CuKα radiation. Following XRD analysis, results were corrected to the appropriate 2 theta spacing using 'Traces' software, and quantification of mineral phases was performed by expressing the composition of crystalline material within each sample as a percentage of dry weight using 'SiroQuant^{TM} v4' software. For each sample, background values were subtracted and analysis conducted until minimum chi-square values were obtained. Raw CPI files from the XRD equipment can be found online as supplementary data to this article.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships which have, or could be perceived to have, influenced the work reported in this article.

CRediT authorship contribution statement

Rafael C. Carvalho: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Visualization, Writing - original draft, Writing - review & editing. **Colin D. Woodroffe:** Funding acquisition, Investigation, Project administration, Resources, Supervision, Validation, Writing - review & editing.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.dib.2020.105813.

References

[1] R.C. Carvalho, C.D. Woodroffe, Evolution from estuary to delta: alluvial plain morphology and sedimentary characteristics of the Shoalhaven River mouth, southeastern Australia, Estuarine, Coastal and Shelf Science (2020) Under Review.
[2] R.L. Folk, W.C. Ward, Brazos River bar: a study in the significance of grain size parameters, Journal of Sedimentary Research 27 (1957) https://doi.org/10.1306/74D70646-2B21-11D7-8648000102C1865D.

[3] S.J. Blott, K. Pye, GRADISTAT: a grain size distribution and statistics package for the analysis of unconsolidated sediments, Earth Surface Processes and Landforms 26 (2001) 1237–1248 https://doi.org/10.1002/esp.261.
[4] F.J. Pettijohn, P.E. Potter, R. Siever, Sand and sandstone, 2nd ed., Springer-Verlag New York Inc., New York, 1987.
[5] J. Madhavaraju, J.C. García y Barragán, S. Mohammad Hussain, S. Pachaiveedu Mohan, Microtextures on quartz grains in the beach sediments of Puerto Peñasco and Bahia Kino, Gulf of California, Sonora, Mexico, Revista mexicana de ciencias geológicas 26 (2009) 367–379.