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Surface sediment grain-size characteristics of the Bohai, Yellow, and East China seas: a comprehensive survey based on unified laser diffraction analysis

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Abstract

This paper presents a comprehensive grain-size dataset comprising 751 surface sediment samples collected from the Bohai Sea, Yellow Sea, and East China Sea—the three major continental shelf seas of China. Samples were obtained over an extended period from 2001 to 2019 using box samplers in accordance with the national marine survey standard (GB/T 12763.8–2007). All samples were analyzed by a Malvern Mastersizer 2000 laser diffraction particle size analyzer following hydrogen peroxide pretreatment for organic matter removal.

The dataset provides the full grain-size distribution at 0.25 Φ intervals from −0.75 Φ to >10 Φ. The instrument measures directly in micrometres (0.02–2000 μm); we provide two companion data files — one in Φ (phi) scale and one in micrometres (μm) — to accommodate both sedimentological convention and direct instrumental units.The dataset also includes derived Folk–Ward statistical parameters including mean grain size (Mz), sorting coefficient (σi), skewness (Ski), and kurtosis (Kg). Ternary fractions of sand (−1 to 4 Φ), silt (4 to 8 Φ), and clay (>8 Φ) are also included.

Across the dataset, sand content ranges from 0 to 100% (mean 40.1%), silt from 0 to 76.8% (mean 41.3%), and clay from 0 to 50.3% (mean 18.6%). Mean grain size (Mz) ranges from 1.51 to 8.13 Φ (mean 5.26 Φ, corresponding to approximately 26 μm). The dataset is expected to support research on sediment dynamics, paleoenvironmental reconstruction, benthic habitat mapping, and marine engineering across the Chinese continental margin. All data are archived in

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Short Summary

We measured grain size in 751 seafloor samples from China's three major shelf seas. The results show a clear pattern: sediments become coarser from north to south, with fine river mud in the Bohai Sea and ancient sandy deposits on the East China Sea shelf. All analyses followed a single consistent protocol, making this the first unified dataset covering the entire Chinese continental margin. These data are freely available to support ocean research and coastal management.

1. Introduction

Grain-size distributions of marine sediments serve as fundamental physical properties that record information about sediment sources, transport pathways, hydrodynamic conditions, and depositional environments (Folk, 1966; McLaren, 1981). In continental shelf settings, the spatial variability of sediment texture directly reflects the interplay between terrestrial sediment supply, tidal and wave energy regimes, and biological activity (Gao & Collins, 2014). Systematic grain-size data are therefore essential for a wide range of applications, including sediment budget estimation, numerical modeling of sediment transport, benthic habitat characterization, paleoenvironmental reconstruction, and marine spatial planning.

The Chinese continental shelf seas—the Bohai Sea, Yellow Sea, and East China Sea—constitute one of the world's most extensive and sedimentologically dynamic shelf systems. These marginal seas receive enormous sediment inputs from major rivers including the Yellow River (Huanghe) and the Yangtze River (Changjiang), while being shaped by the East Asian monsoon, strong tidal currents, and the Kuroshio Current system (Milliman & Farnsworth, 2011; Bianchi & Allison, 2009). Extensive geological surveys have been conducted across these seas over recent decades, producing large volumes of grain-size data. However, much of this information remains dispersed across individual research publications, institutional reports, and proprietary databases, with varying measurement protocols and data formats. The absence of a unified, machine-readable, quality-controlled grain-size dataset has hindered regional synthesis studies and data-driven modeling efforts.

To address this gap, we present a standardized dataset of laser diffraction grain-size measurements for 751 surface sediment samples collected from 2001 to 2019 across the Bohai Sea, Yellow Sea, and East China Sea. All samples were processed using a consistent laboratory

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protocol—Malvern Mastersizer 2000 laser diffraction analyzer following hydrogen peroxide pretreatment—and the resulting data include full grain-size distributions at 0.25 Φ resolution, derived Folk–Ward statistical parameters, and sample metadata (location coordinates, sample identifiers). This dataset aims to provide a high-quality, open-access reference for researchers working on sediment dynamics, marine geology, and Earth system modeling in the East Asian marginal seas.

2. Study Area

The study area encompasses the three major continental shelf seas of China: the Bohai Sea, the Yellow Sea, and the East China Sea (Fig. 1).

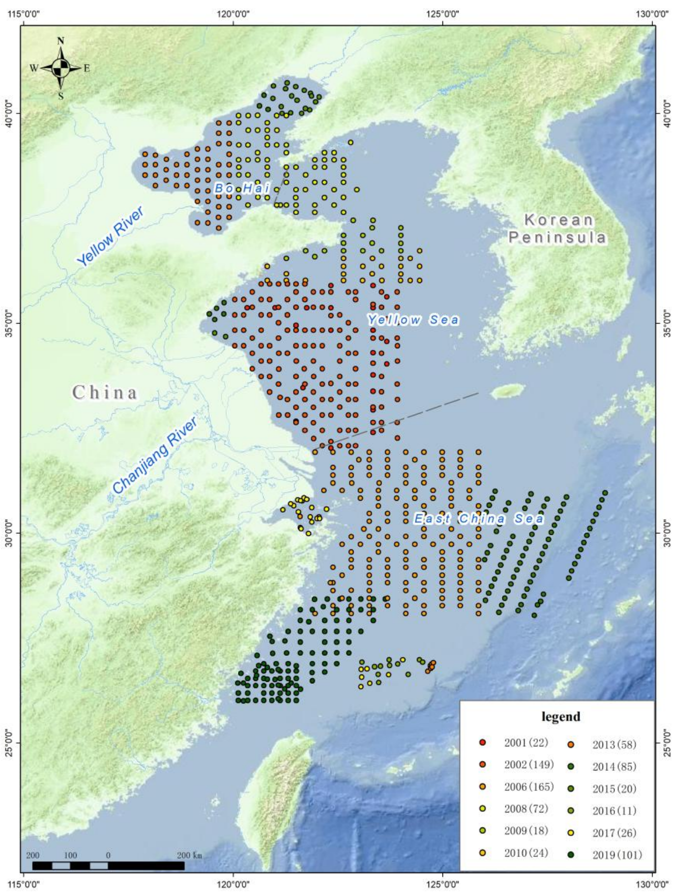

Figure 1. Study area and distribution of 751 sampling stations. Stations are colored by sampling year; numbers in parentheses denote sample count for each year. Dashed lines indicate approximate boundaries of the Bohai Strait and the Yellow Sea–East China Sea transition.

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The Bohai Sea is a semi-enclosed embayment bounded by the Liaodong Peninsula to the north, the Shandong Peninsula to the south, and connected to the Yellow Sea through the narrow Bohai Strait. It has an average water depth of approximately 18 m, receives substantial sediment discharge from the Yellow River (~1.1×10^9 t yr^{-1} historically, though greatly reduced in recent decades), and is characterized by fine-grained sedimentation in its central basins and coarser deposits near the strait (Qin et al., 1990; Wang et al., 2010).

The Yellow Sea is a semi-enclosed epicontinental sea between mainland China and the Korean Peninsula (our sampling stations are concentrated in the central and western Yellow Sea, extending eastward to 125.85°E), with an average depth of 44 m. It can be divided into the North Yellow Sea (north of ~37°N) and the South Yellow Sea, which is influenced by the discharge of the Yangtze River and characterized by a central mud deposit (the South Yellow Sea Mud) that has accumulated since the Holocene (Yang et al., 2003). The Yellow Sea Warm Current and coastal currents exert strong controls on sediment dispersal.

The East China Sea is a broad epicontinental shelf sea with an average depth of 72 m in the shelf region (to the 200 m isobath). It receives the Yangtze River discharge (~4.7×10^8 t yr^{-1}) and is characterized by along-shelf mud deposits and extensive relict sandy sediments on the outer shelf (Liu et al., 2007; Xu et al., 2012). This region is influenced by the Kuroshio Current, Taiwan Warm Current, and the East China Sea coastal current system.

3. Data and Methods

3.1 Sample Collection

Surface sediment samples were collected during multiple cruises between 2001 and 2019 using box samplers, following the Specifications for Oceanographic Survey (GB/T 12763.8–2007). Samples obtained after 2005 were primarily collected from the R/V Yezhizheng (operated by the Qingdao Institute of Marine Geology and renamed R/V Marine Geology NO. 7 in 2020), whereas pre-2005 samples were collected from chartered vessels, for which detailed vessel records are no longer available. The top 0–5 cm of sediment was subsampled from each box core, placed in sealed polyethylene bags, and stored at room temperature prior to laboratory analysis. A total of 751 samples with valid coordinates and grain-size measurements are included in the dataset, distributed as follows: 107 from the Bohai Sea, 258 from the Yellow Sea, and 386 from the East China Sea (Fig. 1).

3.2 Laboratory Analysis

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All grain-size analyses were performed at the Qingdao Institute of Marine Geology, China Geological Survey, using a Malvern Mastersizer 2000 laser diffraction particle size analyzer (Malvern Panalytical, UK). The instrument measures particle sizes in the range of 0.02–2000 μm with an accuracy of ±1% on volume median diameter for standard reference materials.

Prior to measurement, approximately 1–2 g of homogenized sediment was treated with 30% hydrogen peroxide (H_2O_2) at room temperature for 24–48 h to remove organic matter, following the national standard GB/T 12763.8–2007. After digestion, samples were dispersed in deionized water with sodium hexametaphosphate as a dispersant and ultrasonicated for 60 s immediately before measurement to ensure complete disaggregation. Each sample was measured in triplicate, and the average volume percentage for each size bin was reported.

The instrument output consists of volume percentages for 100 size bins spanning 0.02–2000 μm. For this dataset, the distribution was resampled to 45 Φ-scale bins at 0.25 Φ intervals from −1 Φ(2000 μm) to >10 Φ(<0.98 μm), using the $\Phi = -\log_2(d/d_0)$ transformation with reference diameter $d_0 = 1$ mm.

3.3 Data Processing

Folk and Ward (1957) graphical statistical parameters were calculated from the cumulative grain-size distribution curves: $Mz = (\Phi_{16} + \Phi_{50} + \Phi_{84})/3$; $\sigma i = (\Phi_{84} - \Phi_{16})/4 + (\Phi_{95} - \Phi_5)/6.6$; $Ski = (\Phi_{16} + \Phi_{84} - 2\Phi_{50})/(2(\Phi_{84} - \Phi_{16})) + (\Phi_5 + \Phi_{95} - 2\Phi_{50})/(2(\Phi_{95} - \Phi_5))$; $Kg = (\Phi_{95} - \Phi_5)/(2.44(\Phi_{75} - \Phi_{25}))$. Percentile values (Dx) were obtained by linear interpolation between adjacent Φ bins of the cumulative volume curve. Sediment textural classification follows the Udden–Wentworth scale: sand (−1 to 4 Φ, 63–2000 μm), silt (4 to 8 Φ, 3.9–63 μm), and clay (>8 Φ, <3.9 μm).

4. Data Description

4.1 Dataset Structure

The dataset is provided as two companion Microsoft Excel (.xlsx) files, each containing 751 rows (samples) and 76 columns: (1) a Φ-unit version (grain_size_chinese_shelf_seas_751_with_sea.xlsx) with grain-size bins and statistical parameters expressed in φ scale, and (2) a μm-unit version (grain_size_chinese_shelf_seas_751_micron.xlsx) with bin boundaries and length-scale parameters (Mz, Md, Dx, φ percentiles) expressed in micrometres (bin boundaries reflect the original instrument output; φ-derived statistical parameters are presented in μm via $D = 1000 \times 2^{-\varphi}$), while sorting (σi, σi*) and shape parameters (Ski, Ski*, Kg, Kg*) remain in φ-scale or

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dimensionless. Both files include a Sea Area column (Bohai Sea, Yellow Sea, or East China Sea). The data columns are organized in the following groups: (1) Sample identification and location: sample ID, sampling year, and longitude/latitude coordinates (WGS84); (2) Sea area classification; (3) Grain-size distribution: volume percentages in 45 φ-interval bins from −1 φ to >10 φ at 0.25 φ resolution; (4) Textural fractions: sand (−1 to 4 φ, %), silt (4 to 8 φ, %), clay (>8 φ, %); (5) Percentile parameters: D_5, D_{16}, D_{25}, D_{50}, D_{75}, D_{84}, D_{95} expressed in φ (Φ-unit file) or µm (µm-unit file); (6) Folk–Ward parameters: mean grain size Mz (φor µm), sorting coefficient σi, skewness Ski, kurtosis Kg.

4.2 Spatial Distribution of Samples

The 751 sampling stations cover the continental shelf areas of the three marginal seas at water depths ranging from less than 10 m in nearshore Bohai Sea to approximately 200 m at the outer East China Sea shelf edge (Fig. 1). The Yellow Sea and East China Sea samples form broad latitudinal transects, whereas the Bohai Sea samples are concentrated within the Bohai embayment. Sampling density is generally higher in the Yellow Sea (especially the South Yellow Sea) and the inner East China Sea shelf, while the outer East China Sea shelf and the northernmost Yellow Sea have relatively sparse coverage (Fig. 1).

4.3 Grain-Size Characteristics

The dataset exhibits a broad range of sediment types from pure sand to silty clay, reflecting the diverse depositional environments across the Chinese continental shelf. Summary statistics for the principal grain-size parameters are presented in Table 1 and Fig 2.

Sand content varies from 0 to 100% (mean 40.1%, SD 31.5%), silt from 0 to 76.8% (mean 41.3%, SD 21.6%), and clay from 0 to 50.3% (mean 18.6%, SD 12.0%). On the Shepard ternary diagram (Fig. 2), the samples plot across all textural classes, with a pronounced cluster in the silt and sandy silt region.

The mean grain size (Mz) ranges from 1.51 to 8.13 Φ (mean 5.26 Φ, SD 1.67 Φ), encompassing very coarse sand to very fine silt. For reference, the overall mean Mz of 5.26 φ corresponds to approximately 26 µm ($D = 1000 \times 2^{-\varphi}$). The sorting coefficient (σi) ranges from 0.41 (well sorted) to 3.30 (very poorly sorted), with a mean of 2.14, indicating predominantly poor sorting typical of fluvial-influenced shelf environments. Skewness (Ski) ranges from −2.39 (strongly coarse-skewed) to 3.06 (strongly fine-skewed), with a mean of 1.51, reflecting a prevalence of fine-skewed distributions characteristic of muddy shelf deposits.

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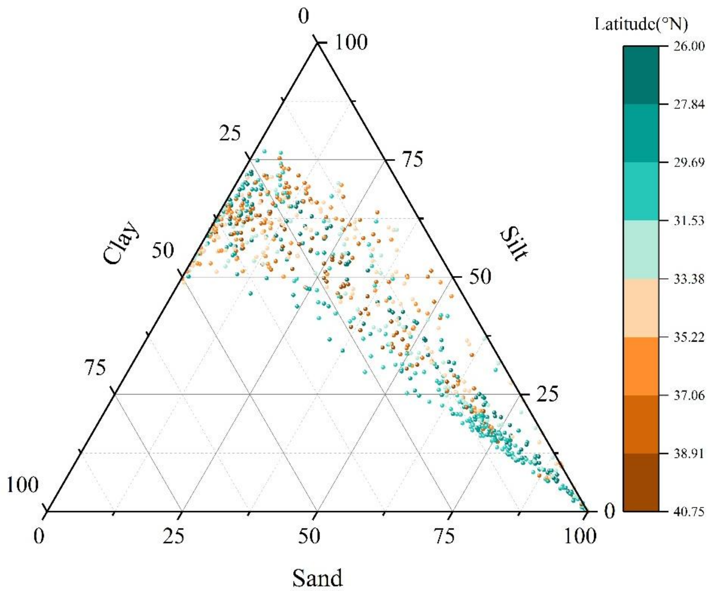

Figure 2. Shepard ternary diagram of sand–silt–clay composition for all 751 samples, colored by latitude bands.

Table 1. Summary statistics of grain-size parameters for the full dataset and each sea area.

Parameter			*Sand (%)*	*Silt (%)*	*Clay (%)*	*Mz (Φ)*	*σi (Φ)*	*Ski*	*Kg*	*Md (Φ)*
All	**(n=751)**	**Mean**	40.1	41.32	18.58	5.26	2.14	1.51	2.85	4.83
		SD	31.52	21.57	12	1.67	0.51	1.22	0.59	1.94
		Min	0	0	0	1.51	0.41	-2.39	0.52	1.41
		Max	100	76.79	50.31	8.13	3.3	3.06	3.87	8.01
Bohai Sea	**(n=107)**	**Mean**	28.03	50.52	21.45	5.82	2.23	1.63	2.87	5.4
		SD	23.42	16.43	9.32	1.21	0.36	0.87	0.39	1.49
		Min	0.08	7.69	3.28	2.16	1.24	-1.69	2.1	1.41
		Max	87.18	75.35	39.06	7.7	2.98	2.92	3.71	7.47
Yellow Sea	**(n=258)**	**Mean**	30.51	48.12	21.36	5.74	2.05	1.24	2.71	5.39
		SD	27.85	17.76	13.28	1.53	0.46	1.23	0.52	1.77
		Min	0.19	0	0	1.51	0.49	-2.03	0.62	1.41
		Max	100	73.15	50.31	8.13	3.28	2.99	3.85	8.01
East China Sea	**(n=386)**	**Mean**	49.85	34.23	15.92	4.78	2.17	1.65	2.94	4.3
		SD	32.7	22.73	11.14	1.73	0.57	1.26	0.66	2
		Min	0	0	0	1.59	0.41	-2.39	0.52	1.64
		Max	100	76.79	48.74	8.03	3.3	3.06	3.87	7.95

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4.4 Spatial Patterns

Clear regional differences in sediment texture are evident from the spatial distribution maps (Fig. 3). The Bohai Sea samples are predominantly fine-grained (mean Mz = 5.82 Φ), with silt and clay fractions collectively exceeding 70% at most stations, reflecting the dominant influence of Yellow River-derived fine sediment. The Yellow Sea samples in our survey area are predominantly fine-grained, with silt-dominated textures concentrated in the central South Yellow Sea mud deposit. The East China Sea samples display the greatest textural diversity, with inner shelf mud deposits near the Yangtze estuary (fine-grained), extensive relict sandy deposits on the outer shelf (coarse-grained), and transitional mixed sediments on the mid-shelf.

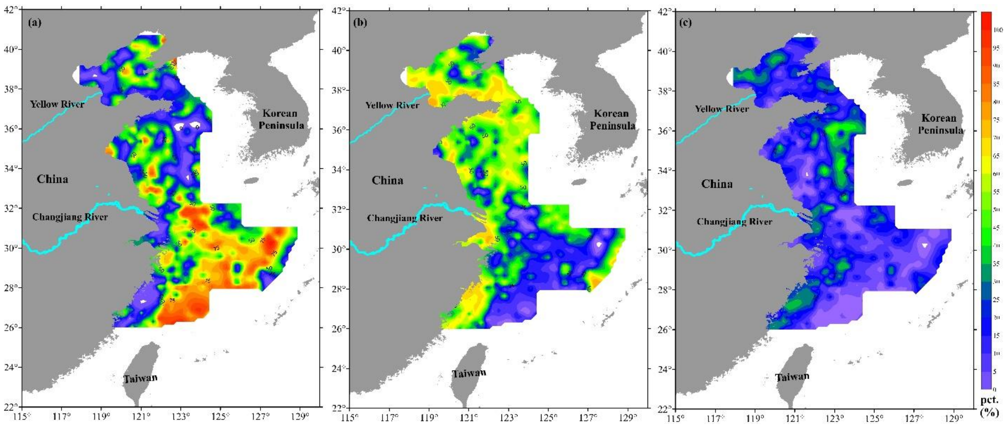

Figure 3. Spatial distribution of (a) sand content, (b) silt content, and (c) clay content. Sand: 63–2000 µm; silt: 3.9–63 µm; clay: <3.9 µm (after the Udden–Wentworth classification).

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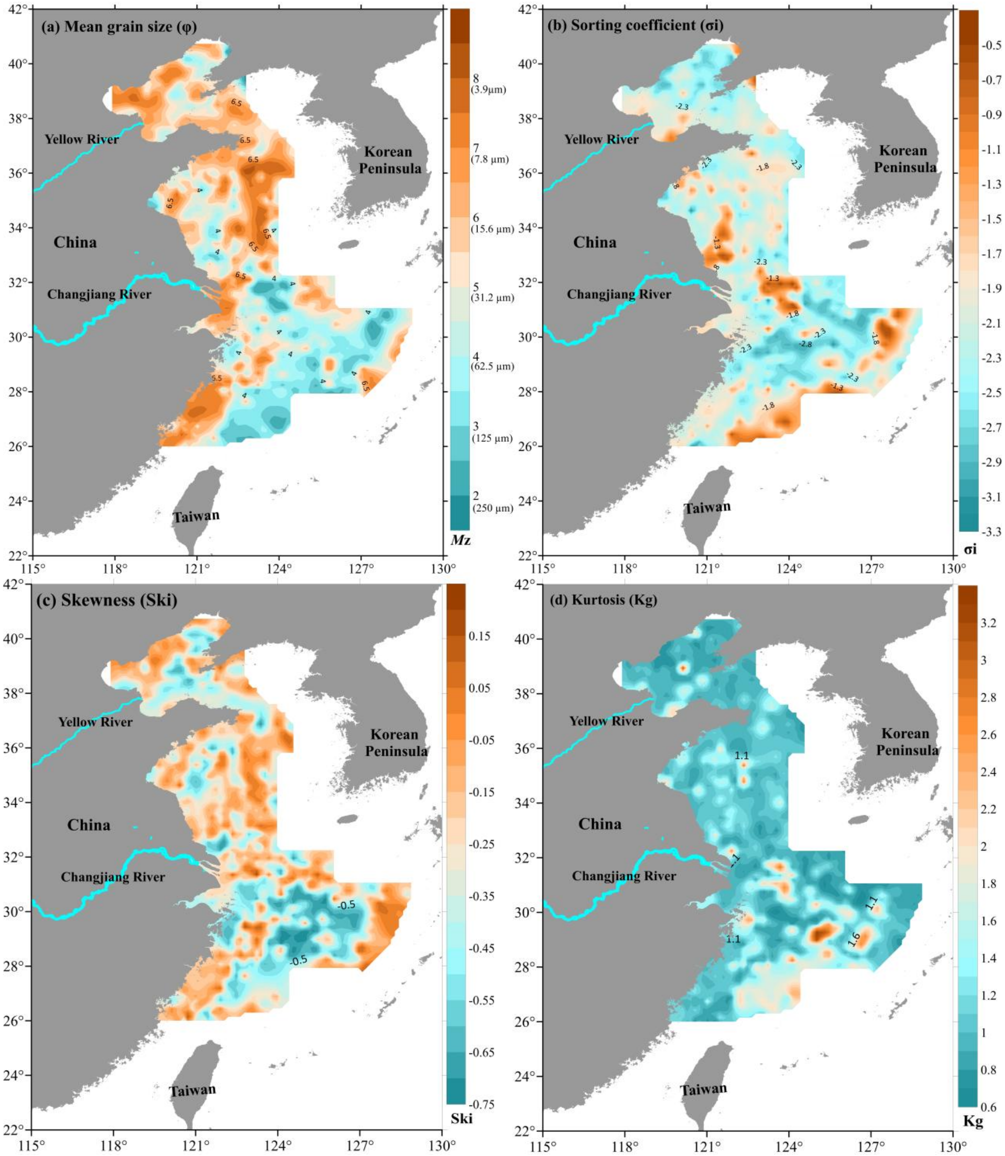

Figure 4. Spatial distributions of grain size parameters (Mz, σi, Ski, Kg) of surface sediments in the Bohai Sea, Yellow Sea and East China Sea. (a) Mean grain size (Mz, φ); (b) Sorting coefficient (σi); (c) Skewness (Ski); (d) Kurtosis (Kg). Mz values are in φ units; the companion μm-unit data file provides corresponding micrometre values (conversion: $D = 1000 \times 2^{-\varphi}$).

5. Data Quality Assessment

5.1 Measurement Precision

Analytical precision was assessed through triplicate measurements of each sample following repeat dispersion. The coefficient of variation (CV) for D_{50} was typically below 3% for silty and

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clayey samples and below 5% for sandy samples with bimodal distributions. The median grain size (D_{50}) showed the highest reproducibility, followed by D_{16} and D_{84}, consistent with the expectation that distribution tails are inherently more variable in laser diffraction analysis.

5.2 Methodological Considerations

Laser diffraction is now the standard method for grain-size analysis in marine sedimentology due to its speed, high resolution, and excellent reproducibility (Loizeau et al., 1994; McCave et al., 2006). However, several considerations should be noted when using this dataset:

Organic matter removal: The H_2O_2 pretreatment effectively removes labile organic matter, but refractory organic matter and bio-mineral aggregates may persist. For sediments with high organic carbon content (>2%), the reported grain-size distribution may be slightly coarser than the in situ grain-size spectrum of mineral particles alone.

Clay fraction quantification: Laser diffraction tends to underestimate the clay fraction relative to the pipette method, particularly for platy clay minerals such as illite and smectite dominant in Chinese shelf sediments (Konert & Vandenberghe, 1997). Users comparing this dataset with historical pipette-method data should apply caution, especially for clay-dominated samples.

Carbonate content: No acid pretreatment was applied for carbonate removal. In the study area, biogenic carbonate content is generally low (<5%) in most shelf sediments, though locally elevated carbonate concentrations (e.g., shell hash layers) may bias the grain-size distribution toward coarse fractions.

Spatial sampling bias: Sampling density is uneven across the study area. The inner East China Sea shelf and South Yellow Sea are relatively well represented, whereas the outer shelf of the East China Sea and some estuarine zones have sparse coverage.

5.3 Comparison with Existing Data

To our knowledge, this dataset represents the most comprehensive open-access compilation of uniformly measured grain-size data for surface sediments across all three Chinese marginal shelf seas. Previous regional datasets were typically limited to single sea areas or specific survey transects. The consistent analytical protocol (single instrument, single laboratory, unified pretreatment) ensures internal comparability across the entire study region, which is a significant advantage for basin-scale synthesis studies.

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6. Data Availability

The dataset described in this paper is archived at Science Data Bank and is available under the Creative Commons Attribution 4.0 International license (CC BY 4.0). The dataset can be accessed at: https://doi.org/10.57760/sciencedb.41730 (Duan et al.,2026).

The dataset comprises two companion files: the primary data file (grain_size_chinese_shelf_seas_751_with_sea.xlsx, Φ-unit version) and companion file (grain_size_chinese_shelf_seas_751_micron.xlsx, μm-unit version), each containing 751 rows and 76 columns as described in Section 4.Both files are accompanied by a README.txt file with descriptions of all variables, measurement methods, unit conventions, and quality flags.

For any questions regarding the dataset, please contact the corresponding author at dxiaoyong@mail.cgs.gov.cn or duan-xy@qq.com.

7. Conclusions

This paper presents a uniformly measured laser diffraction grain-size dataset for 751 surface sediment samples covering the Bohai Sea, Yellow Sea, and East China Sea. The dataset provides full grain-size distributions, derived Folk–Ward statistical parameters, and textural fractions (sand, silt, clay), all generated under a consistent analytical protocol at a single laboratory.

The spatial coverage spans over 14 degrees of latitude and 11 degrees of longitude, encompassing environments from nearshore estuarine muds to outer shelf relict sands. This dataset is expected to facilitate a wide range of applications, including regional sediment transport modeling, paleoenvironmental studies, benthic habitat mapping, calibration of remote sensing algorithms, and baseline surveys for marine environmental monitoring. We encourage the scientific community to use and build upon this dataset. Future updates may include additional samples from under-represented areas and integration with geochemical and mineralogical datasets.

Author Contribution

XD conceptualized the study, curated the data, performed the formal analysis, conducted the investigation, developed the methodology, created the visualizations, and wrote the original draft. BC (second author), SW, and JZ contributed to sample collection and data organization. ML performed data processing and figure preparation. PY contributed to the overall study design and methodology. BC (last one) performed data trend analysis and supervised the project. All authors reviewed and approved the final manuscript.

Competing Interests

The authors declare that they have no conflict of interest.

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