Data Article

Lithostatistical variability of beach gravels along the Polish coast of Baltic Sea: The Pogorzelica–Dziwnów dataset (363.0–391.4 km)

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ABSTRACT

The data presented in the article consist of petrographic types and grain shape parameters of beach gravels collected along the Pogorzelica–Dziwnów coast section (363.0 to 391.4 km of the coastline), southern Baltic Sea, Poland. Representative gravels with the diameter of 2-5 cm were sampled at 0.25 km intervals, in the middle part of the beach. The contribution of mechanically high resistant crystalline components (igneous and metamorphic rocks: granites and gneisses) and low resistant (sedimentary rocks: limestones, sandstones, and shales) has been presented. The Cailleaux and Zingg grain shape parameters were estimated taking laboratory measurements (3D-axis dimensions, flatness/roundness indices). The calculations have been provided based on the gravels weight and quantity. The obtained grain shape parameters depend on factors such as resistance to mechanical destruction or increased chemical weathering, being evidenced by several indices, such as the proportions between discoidal and ellipsoidal grains, or amount of spindle-shaped gravels. The calculated indices may serve as potential indicators of coastal lithodynamics, including inten-

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Value of the Data

- The dataset is a first detailed repository of beach gravels variability in the Western Pomerania, Baltic Sea, Poland. Calculated grain shape indices may be related with coastal zone dynamics expressed by intensity of erosion processes and reworking of the material in the shallow foreshore zone. The proportions between mechanically resistant rocks (migmatic and metamorphic: granites and gneisses) and non-resistant rocks (sedimentary: limestones and sandstones) and proposed shape parameters are potential predictors of coastal lithodynamics.
- The data may be useful for maritime administration of Poland, EU, or various research teams investigating the impacts of maritime infrastructure on coastal dynamics, erosion intensity, or beach nourishment planning.
• The dataset can be used as reference material for studies on coastal morpholithodynamics, impacts of maritime infrastructure, Quaternary geology of Baltic Sea, or as a methodical guide of petrographic data application for lithostatistical analysis of coastal erosion.

1. Data Description

The dataset consists of two MS Excel (.xlsx) files:

1. Spreadsheet_1 – includes measurement data of each sampling station (N=104; in kilometres) located along the Pogorzela-Dziwnów coast section, Poland. The Zingg-based parameters have been grouped into major 4 petrographic classes: crystalline, limestone, sandstone, and other. The average content of gravels in each class, mean 3D dimensions of each gravel (axes A, B and C; in centimetres), as well as four major classes of roundness (spherical, discoidal, ellipsoidal, spindle) with two minor subclasses (bladed-ellipsoidal, spindle) has been presented. Additionally, the data contains Cailleaux roundness and flatness indices [1]. Sampling stations without any gravels collected (n=0; only sandy beach sections) have been indicated as an empty sheets. The last sheet 'summary' (marked with a green tab), consists of full grain shape parameters grouped into one table. The data in each petrographic class have been grouped according to the C/B and B/A Zingg parameters, which is marked with a different colours [2].

2. Spreadsheet_2 – the data include content of gravels in each petrographic class, collected at 104 sampling stations, described separately as 'weight' and 'number of grains'. Spreadsheet consists of two major sheets: (i) 'amount', and (ii) 'summary'. The first one shows gravels in petrographic classes, sorted separately by 'weight' and 'number of grains'. The data consist of cumulated % values, as well as calculated ratios between petrographic classes, which can be applied as a potential indicators of reworking processes in the coastal zone [3]: (i) limestone+sandstone/crystalline (l+s/d), (ii) crystalline/limestone (c/l), (iii) limestone+other/crystalline+sandstone (l+o/c+s), and (iv) sandstone/limestone (s+l). Additionally, the basic statistics, normalized 'weight index' (weight/number of gravel grains) and 16 graphs (each of distinguished petrographic class) have been included. The tendencies presented on the graphs (see example in the Fig. 1a,b) have been smoothened by application of running average (period of 2) and polynomial regression (6th degree). The second sheet ('summary'; marked with a green tab) consists of full petrographic classes data along the investigated coast section, evidenced by Zingg form index and 16 graphs of shape classes. As before, the graphs data have been smoothened by application of polynomial 6th deg. trend line (see example in the Fig. 2a,b). The 2nd degree running average smoothen the values along investigated coastal section, whereas the 6th degree polynomial trend represents the major fluctuations of coastal dynamics with reduced anomalous factor.

2. Experimental Design, Materials and Methods

The petrographic composition and grain shape parameters of beach gravels are indicators of potential sources of initial rocks or directions of transport in the coastal zone. Additionally, the comparison of gravel ratios calculated in individual petrographic classes and initial rocks derived from active cliff sections allows to conduct qualitative assessment of intensity of gravel-destructing processes, which may be related with mechanical reworking and chemical weathering [4,5].

Among several lithostatistical parameters, the ‘gravel shape’ indices are useful for interpreting coastal dynamics, as well as the potential processes of material deposition-redeposition [6]. When assessing the intensity of shore erosion, lithodynamics of the coastal zone may be subject to rank-based evaluation based on several parameters, including 'flatness index', 'roundness index', or 'weight index' [7,8].
The distinguished petrographic classes presented here include: (i) mechanically high resistant igneous and metamorphic crystalline rocks with dominant quartz; (ii) mechanically low resistant limestones; (iii) mechanically low resistant sandstones, dolomites, and (iv) other (shales, flints, bricks and concrete fragments).

The collected samples consisted of 92–336 gravel grains each. The basic statistical parameters of the grain shape indices and petrographic groups classification (arithmetic and running averages, standard deviations ±σ) were calculated for the dataset consisting of 113 sampling stations and total number of 17,882 gravel pebbles. The mean number of gravel grains collected from a single station was 172. At nine stations, gravels have not been found, so only 104 stations are useful for the further studies.

The grain axes were measured in separate petrographic classes to arrive at the maximum length, maximum width, and maximum height. The gravels morphometry was determined using Cailleaux flatness index (Ws), and by the gravel shape parameters (A/B and C/B ratios), as described by Zingg [1, 2]. The Ws was estimated using equation: Ws=100(A+B)/2C. The roundness index was calculated after Cailleaux: R = 1000C/A, where 1000 means the ‘perfect sphericity’, and 0 means ‘extreme flatness’. Additionally, the petrographic indices, such as: (i) limestone+sandstone/crystalline (l+s/d), (ii) crystalline/limestone (c/l), (iii) limestone+other/crystalline+sandstone (l+o/c+s), and (iv) sandstone/limestone (s+l) were calculated [3, 9].

Applied Zingg’s method describes the grain shape based on: (i) the ratio between the intermediate (B) and longest (A) axis, and (ii) the ratio between the shortest (C) and intermediate sizes.
(B) axis. The gravel grains were classified by their shape as discoidal, ellipsoidal, spheroidal, and spindle.

The petrographic composition presented in both datasheets was determined as a: (i) mass percentage of gravel grains in each petrographic class, (ii) percentage of individual gravel pieces at each sampling station. The percentage and weight of gravels was compared with number of gravels in individual petrographic classes.

In case of crystalline gravels, the ratio of weight fraction and number of individual gravels has been shown in Fig. 1a. The calculated mean is 1.05 ± 0.11 (σ), which indicates similarity of both results and high mutual dependence of the presented parameters. On the other hand, limestone gravels, which are usually affected by more intensive mechanical and chemical reworking in the shallow foreshore zone compared to crystalline components, exhibit mean values reduced to 0.9, and σ increased to ± 0.29 (Fig. 1b), expressing greater susceptibility of limestones to alongshore movement and reworking processes. Similar behaviour has been observed in the class of sandstones.

The percentage of petrographic components in terms of quantity (number of grains) indicate much greater standard deviation, e.g. in case of limestones, suggesting that limestone and sandstone gravels are more susceptible to mechanical or chemical reworking, compared to crystalline gravels. The share of the other components is too low for any interpretation, and shall be omitted in any further statistical consideration.

The proposed petrographic indicators calculated as ratios between different petrographic classes of components (l+s/d, c/l, l+o/c+s, s+l, +other variations) may be useful for the assessment of lithodynamics in the shallow foreshore zone [5]. Positive anomalies between sedimen-
tary and crystalline gravels, or A/B ratio may suggest a slight advantage of accumulation over erosion, whereas the negative anomalies may indicate more intensive reworking of sedimentary material.

The greater share of discoidal grains, in relation to the average, indicates periodic accumulation occurring in the shallow foreshore (=delivery of fresh, non-reworked gravels) (Fig. 2a,b). On the other hand, the greater amount of spindle-shaped and nodular grains, compared with the average, may suggest an increased erosion processes (=reworking of gravels). Additionally, the debris deficiency in the foreshore may be evidenced with a negative s/c, A/B, and positive c/l, s/l anomalies (e.g. [5]).

Application of smoothing factor, e.g. polynomial regression detrending, provides good illustration of lithodynamics in the coastal zone, however it shall be mentioned that extreme graph segments are an exception, which makes them non-reliable for further analysis.

3. CRediT Author Statement

**Cyprian Seul:** Conceptualization, Investigation, Methodology, Software, Writing-Original draft preparation, Visualization. **Roman Bednarek:** Data curation, Supervision, Funding acquisition. **Tomasz Kozłowski:** Investigation, Visualisation, Data curation. **Łukasz Maciąg:** Supervision, Validation, Writing-Reviewing and Editing.

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.

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