

Study on Spatial Variation of Grain Size of Seafloor Sediments around Ishikawa Coast

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1. Introduction

The cross-sectional topography shows periodic changes from year to year, with erosion and accumulation occurring at different depths on the Ishikawa Coast. Problems such as erosion of the northern coast and burial of Kanazawa Port can occur due to unbalances of sediment transport around the coast. Kanazawa Port is located in a position that hinders the transport of sediment supplied from Mt. Hakusan to the northern coast via the Tedoru River. To take appropriate countermeasures against such problems, it is important to accurately estimate sediment transport in riverine and coastal areas.

To estimate the movement of sediment drift along the Ishikawa Coast near the mouth of the Tedoru River, we collect sediments from the seafloor over a wide area, and examine a great deal of sediment quality such as grain size and shape characteristics. The relationship between spatial variation of sediment quality and the direction of net sediment transport is discussed.

2. Study Area

Sediment sampling was conducted in October 2020 and September 2021 along 40 km stretch of the coast from Shinbori River mouth to Uchinada coast. As shown in Figure 1, the sampling points between 5 to 22m in depth are located in the left and right areas of the Tedoru River mouth. In the longshore direction, samples were taken at the depth of 15m along Ishikawa coast, and at the depth of 22m along Kanaiwa coast.



Figure 1. Location of sediment sampling points plotted on Google Earth

3. Method

3.1. Data Analysis

By using the sieving test, we got the value of grain size, and then counted grain characteristics such as mean, sorting and skewness. We used a scanner to obtain magnified images of the sediment particles. To examine the direction of net longshore sediment transport, we found the roundness ratio R by using image analysis with MATLAB. R approaches 1.0 for a perfectly round particle. Assuming that the shape of the particle is circular, the value of roundness R was calculated with the area, and the perimeter of a sand particle.

3.2. Transport model

This study used two types of hypothetical trends on the sediment transport vectors proposed by McLaren and Bowles (1985) and Gao and Collins (1991). If all three parameters (mean μ , sorting σ , and skewness Sk) are considered, then two grain-size trends will dominate, assuming that the net transport is from sampling site 1 to 2:

$$\text{Case 1: } \sigma_2^2 \leq \sigma_1^2, \mu_2 > \mu_1 \text{ and } Sk_2 \leq Sk_1 \quad \text{and} \quad \text{Case 2: } \sigma_2^2 \leq \sigma_1^2, \mu_2 < \mu_1 \text{ and } Sk_2 \geq Sk_1$$

In the present study, we used both of Case 1 and Case 2 as trends associated with net sediment transport direction.

4. Result

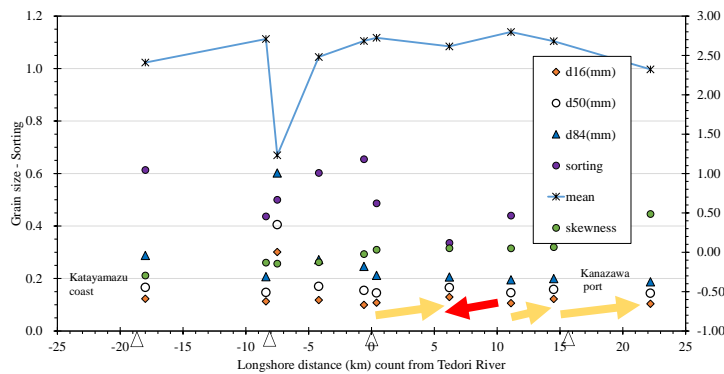


Figure 2. Grain Size and Characteristics of sediments sampled at the water depth of 10-15m

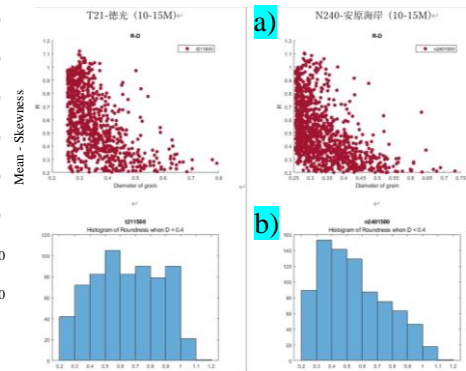


Figure3. Correlation of Roundness and Diameter at 2 sites

Figure 2 shows the grain size (d50, d16, d84) and the mean, sorting, and skewness indexes in the longshore with the Tedoru River as a landmark. The indexes are calculated by following Folk and Ward (1957). Here, d16 is the particle size value with a cumulative frequency of 16% from the grain size, the same for d84. At a depth of 10-15m, the median grain diameter is maintained at about 0.1-0.2mm, but near Kakehashi River (-7 km), d50 approximately reaches a peak of 0.4mm. With the sorting index, which indicates the degree of sorting, in the right side of Tedoru River is less than 0.5 for well-sorted. The sediment in the left side of Tedoru River has a negative skewness, meaning that the central particle size is significantly biased toward a finer-than-average particle size. On the opposite side of Tedoru River, skewness is a positive value, meaning that the central particle size is significantly biased toward a coarser than average particle size.

Based on 3 parameters sorting, mean, and skewness, we can see the movement trend of sediments with a depth of 10-15m as shown in Figure 2. To illustrate, 3 out of 4 vectors tend to move in the direction from south to north, while one vector in the opposite direction appears. Figure 3 a) analyzed the correlation between roundness and grain diameter in the Tokumitsu (left side graph) and Yasuhara (right side graph) areas where the opposite vector appears at a depth of 10-15m. Figure 3 b) is about the frequency of occurrence of roundness between that area within the diameter limit $d < 0.4\text{mm}$. The graph highlights the difference in the particle shape ratio on the 2 sides with the condition that the particle diameter $d < 0.4\text{mm}$. At Yasuhara the ratio of round grain size prevails over other shapes, but at Tokumitsu irregularly shaped particles appear with round particles.

Reference:

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