

Identification of Underwater Mountains Using Multibeam Echosounder Data (Case Research of the Waters of Southern Java)

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ABSTRACT

Submarine mountains (seamounts) are important geological features formed by volcanic activity on the seafloor. Their identification and mapping play a crucial role in understanding geological dynamics, conserving marine ecosystems, and supporting sustainable resource management. This research focuses on the identification of seamounts in the southern waters of Java, Indonesia, using Multibeam Echosounder (MBES) data. The MBES data were processed and analyzed with Teledyne Marine PDS hydrographic software to produce bathymetric maps and Digital Elevation Models (DEM). The DEM enabled a detailed visualization of the seafloor morphology, including height, slope gradient, and peak shape of the identified seamounts. The analysis also assessed data accuracy in accordance with International Hydrographic Organization (IHO) standards, confirming that the mapping results met IHO accuracy requirements. This methodological approach demonstrates the capability of MBES and PDS processing to generate reliable topographic information for underwater geological studies. The findings highlight the existence of distinct seamounts in the southern Java waters, providing valuable insights into the region's marine geology. Furthermore, the results contribute to more accurate hydrographic mapping, ecosystem conservation strategies, and sustainable resource exploration in Indonesia. Overall, this study emphasizes the significance of advanced hydrographic technologies in exploring poorly understood seafloor environments and provides a solid reference for future research on submarine topography.

KEYWORDS Bathymetry, Digital Elevation Model, IHO, Multibeam Echosounder, Submarine mountain, Undersea feature.



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INTRODUCTION

Underwater mountains or seamounts are crucial geological formations formed due to volcanic activity on the seafloor (Stratmann et al., 2022). Globally, it is estimated that over 100,000 seamounts exist worldwide, yet less than 20% have been adequately mapped and studied (Yesson et al., 2020). This represents a significant knowledge gap, as approximately 80% of the ocean floor remains unmapped to modern standards, with seamount regions being among the least understood marine environments. Current estimates suggest that only 5% of seamounts have been explored in detail, leaving vast areas of the ocean floor uncharted and their ecological and geological significance largely unknown (NOAA, 2020).

Although its role is vital to the global ecosystem, it is still one of the least understood parts of the ocean, and detailed mapping of seamounts is not only of scientific importance but

also an urgent need globally. These underwater mountains play a role in supporting endemic species, influencing oceanographic dynamics, as well as contributing to the carbon cycle (Rogers, 2018). This knowledge gap is a major challenge, especially as the world faces real threats to the marine environment such as climate change, disaster mitigation, destructive fishing, and increasingly intensive seabed mining (Clark et al., 2019).

Multibeam Echosounder (MBES) technology is a very effective tool in identifying underwater mountains. MBES works by emitting sound waves to the seafloor and recording signal reflections to produce highly detailed bathymetric maps (Bikonis & Demkowicz, 2018; Grządziel & Wąż, 2018; Lubis et al., 2019; Siregar et al., 2024). With the ability to map large and complex areas of the seabed, MBES allows researchers to get a three-dimensional picture of the structure of underwater mountains. This provides more accurate information than methods such as the Singlebeam Echosounder (SBES), which can only provide a two-dimensional profile (Los, 2019; Sarmili & Troa, 2016; Triarso & Arief Troa, 2016).

The use of MBES is not only limited to the identification of underwater mountain morphology but is also important in researching the dynamics of marine geology. With topographic maps, researchers can explore the geological processes that occur around underwater mountains, such as the formation of steep slopes, faults, and ongoing volcanic activity. In addition, MBES also provides information on the interaction of ocean currents with seafloor features, which can affect the distribution patterns of nutrients and marine organisms around underwater mountains (Gevorgian et al., 2023; Yesson et al., 2021).

The Indonesian Continental Shelf Survey (LKI) activities in South Java, Bali, and Nusa Tenggara were carried out from September to November 2022. This LKI survey aims to support the Indonesian continental shelf submission program beyond 200 nautical miles in the southern region of Java, which obtains bathymetric data that will be used in proving roo rise (roo height) as a natural prolongation of the Java mainland, and the position of the foot of slope (FOS) used in the delimitation of the outermost boundary of the continental shelf in the southern region of Java-Bali-Nusa Tenggara.

This activity is a Type 2 self-management activity between BIG and BRIN. The discovery of an underwater mountain approximately 260 km from Pacitan was found in the LKI survey in lanes 16 to 20 with UTM coordinates 111° 02'14.39" 10°38'38.40", where the survey passed through the lane on October 6 to 9, 2022. Although MBES has been used in various marine surveys, seamount mapping in southern Indonesia is still limited, requiring further research to understand the morphology and geological implications of these underwater features in the context of Indonesia's continental shelf boundaries and marine resource management. In the initial research before the survey was carried out, the Continental Shelf Submission Technical Team determined the survey lane by considering the potential for natural prolongation. This research is unique because it: utilizes the latest MBES data from the LKI 2022 survey, focusing on newly discovered seamounts south of Java, and contributes to the scientific basis for marine resource management while supporting Indonesia's continental shelf boundary claims under the United Nations Convention on the Law of the Sea (UNCLOS).

Previous studies in Indonesia have demonstrated the effectiveness of MBES technology in seamount mapping. Suhendra & Wijaya (2020) successfully applied MBES technology for mapping submarine mountains in Indonesian waters, revealing significant morphological

features previously undetected by conventional methods. Budiman & Setiawan (2017) conducted comprehensive seamount identification in Indonesian territorial waters, establishing baseline data for geological and ecological studies. Nasution & Rakhmani (2018) utilized MBES for seafloor morphology identification, contributing to marine resource management and conservation efforts. However, seamount mapping in southern Indonesia remains limited, particularly in the Java Sea region, requiring further research to understand the complete morphology and geological implications of these underwater features.

This research aims to identify underwater mountains using multibeam echosounder data. The specific objectives include: (1) processing and analyzing MBES data to create detailed bathymetric maps of the submarine mountain, (2) generating Digital Elevation Models (DEM) to visualize seafloor topography, (3) conducting slope analysis to understand geological stability, and (4) validating data accuracy according to IHO standards. It is hoped that this research can help understand the geology of the seabed, support the conservation of marine ecosystems, and the exploration of mineral resources with multibeam echosounder (MBES), allowing for accurate mapping, which is important for research and marine resources. The benefits of this research include contributing to Indonesia's maritime boundary determination, providing baseline data for marine conservation efforts, supporting geological hazard assessment in the region, and establishing a foundation for sustainable marine resource exploration. Furthermore, this research enhances understanding of submarine volcanic activity and its implications for regional tectonics and marine biodiversity.

RESEARCH METHOD

The data used in this research is divided into 2, namely Raw Data MBES (Multibeam Echosounder): Bathymetric data collected using the MBES Kongsberg system, which is in KMALL format, and Raw Data SVP (Sound Velocity Profile): Sound velocity data in water used for accuracy correction of MBES depth measurements, and data used are 2022 data. The data was taken at the Geospatial Information Agency

This research was carried out in the waters south of Java, where data collection was carried out in the context of surveying the Indonesian continental shelf. This research uses secondary data collected by the Geospatial Information Agency (BIG) from October 6 to 9, 2022. The data was taken at the coordinates of zone 49S UTM ($111^{\circ} 02' 14.39''$ $10^{\circ} 38' 38.40''$), with the coverage of the area that crosses lanes 16 to 20.

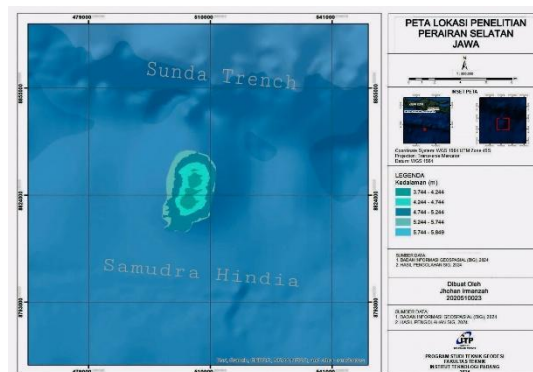


Figure 1. Research Location in the waters south of Java right in the trough that extends towards Bali and Nusa Tenggara.

Identification of Underwater Mountains Using Multibeam Echosounder Data (Case Research of the Waters of Southern Java)

The methodology used in this research is quantitative descriptive. This research aims to identify underwater mountains using *multibeam echosounder* (MBES) data processed using *Teledyne Marine PDS software*. The data used is secondary data from the geospatial information agency at the Directorate of Marine and Coastal Terrain and the analysis is carried out based on international hydrographic organization (IHO) standards

1. Data Collection

using MBES raw data and *Sound Velocity Profile* (SVP).

2. Data Processing

Data conversion, *noise filtering*, creation of *Digital Elevation Model* (DEM), and precision analysis (TVU and THU).

- a. Data Conversion: Converts KMALL format to ALL using *KMALL2ALL_EM304 datagram converter* to be processed in *Teledyne Marine PDS*.

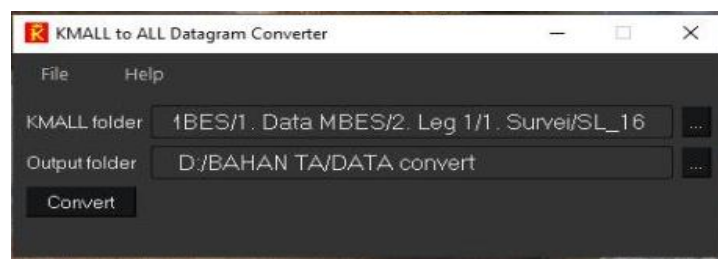


Figure 2. Convert data format KMALL to ALL

- b. Noise filtering: perform automatic and manual filtering to eliminate noise in data and adjust parameters according to IHO standards

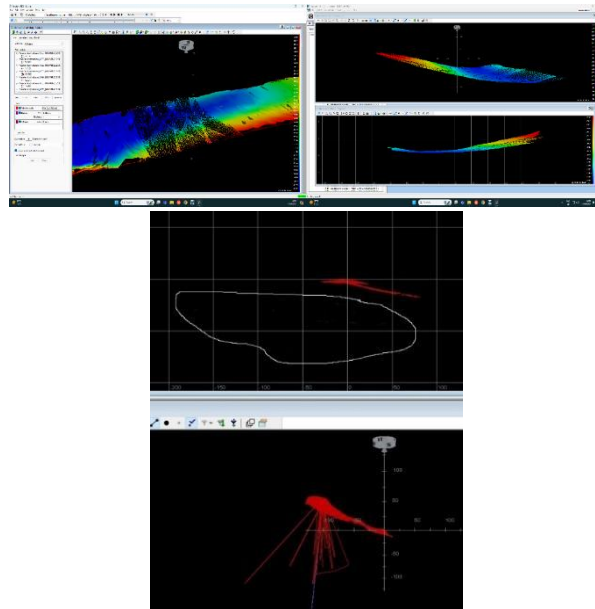


Figure 3 noise filtering and cleaning manual

- c. Digital Elevation Model (DEM) Creation: After the data is clean from noise, a grid model with a density of 50 meters is created to obtain an accurate DEM for the density of the DEM and the depth if the DEM is less dense can be interpolated

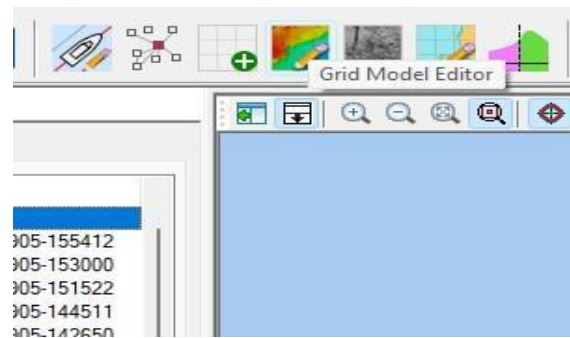


Figure 4 Model grid creation

3. Export and Data Accuracy Analysis:

The DEM results were analyzed by measuring *Total Vertical Uncertainty* (TVU) and *Total Horizontal Uncertainty* (THU) according to IHO standards to ensure the quality of the data produced.

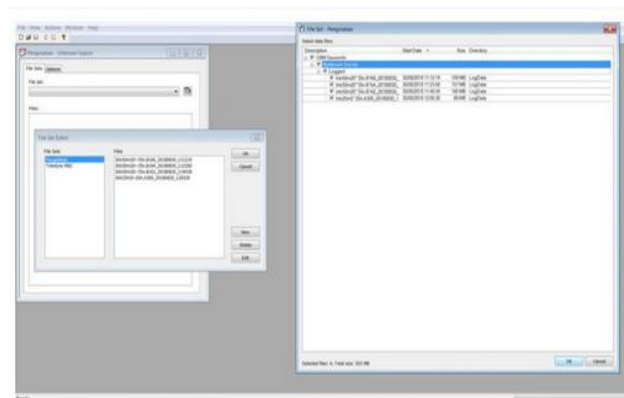


Figure 5. Export total vertical uncertainty (TVU) and total horizontal uncertainty (THU)

RESULT AND DISCUSSION

Sound Velocity Profile (SVP) Results and Analysis

As a result of the sound *velocity profile* analysis at a depth of about 6,000 meters, one of the important factors that must be taken into account is the *Sound Velocity Profile* (SVP), or sound velocity profile, because the speed of sound at sea affects the depth measurement results. Sound speed is affected by factors such as depth, temperature, and seawater salinity On-site SVP data capture as of August 2022

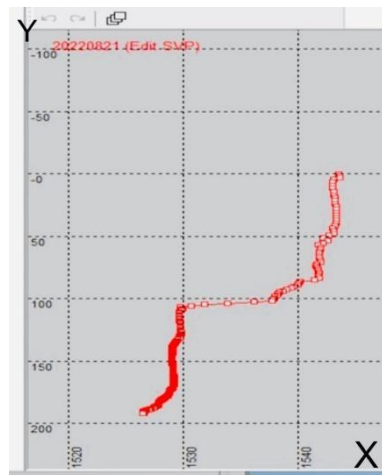


Figure 6. Sound velocity profile (svp)

Figure 6 shows the Sound Velocity Profile (SVP) graph, which depicts the variation in sound speed in water to depth. The Y axis shows the depth that increases downwards, while the X axis shows the speed of sound. These changes in speed are affected by temperature, salinity, and pressure. It can be seen that at shallow depths, the speed of sound reaches 1545 m/s, then decreases to 1527 m/s, before increasing again at greater depths. This phenomenon has to do with the thermocline layer, where significant temperature changes affect the speed of sound. SVP is important in hydrographic surveys and the use of echosounders.

Echosounder Multibeam Data Processing Results with Teledyne PDS Software

The results of multibeam echosounder processing using Teledyne Marine PDS software to identify underwater mountains are in the form of DEM data. Identifying underwater mountains in the waters south of Java After processing multibeam echounder (MBES) data using Teledyne Marine PDS (Process Data Suite) software software, it succeeded in obtaining data digital elevation model (DEM) that accurately depicts the topography of the seabed. The processing process begins with the collection of raw data from the MBES instrument, which includes ocean depth information from various points with a wide angle distribution.

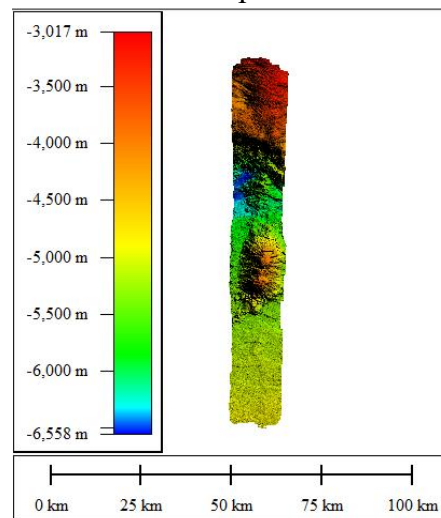


Figure 7. DEM of processing results

Figure 7 above is a waterbed bathymetric visualization that shows variations in depth with different color gradations, where red indicates the shallowest area with a depth of about -3,017 to -3,500 meters, which is likely to be an underwater ridge or plateau. Orange to yellow is at a depth of -3,500 to -4,500 meters, indicating an underwater slope that is beginning to decline. Light green to dark green covers depths of -4,500 to -5,500 meters, describing transitional areas between steep slopes and flatter seabeds. Light blue indicates a depth of -5,500 to -6,000 meters, indicating a deeper part such as an underwater valley. Dark blue is the deepest area, reaching -6,558 meters, which is in the form of a sea trench in the waters of South Java, This change in gradation reflects the complex underwater geological structure.

Multibeam Echosounder Survey Data Results and Analysis

Multibeam echosounder survey (MBES) is a bathymetric measurement technique that produces detailed underwater topographic data. The results of the multibeam echosounder survey (MBES) include information on the depth and relief of the seabed of the surveyed area. The data obtained can include the depth of the seabed, to the characteristics of the seafloor and this data is opened in the Global Mapper software, in the case of surveys with an area between 0 km to 30 km and depths between -3,017 meters to -6,558 meters, here is the definition of results and analyses that can be done:

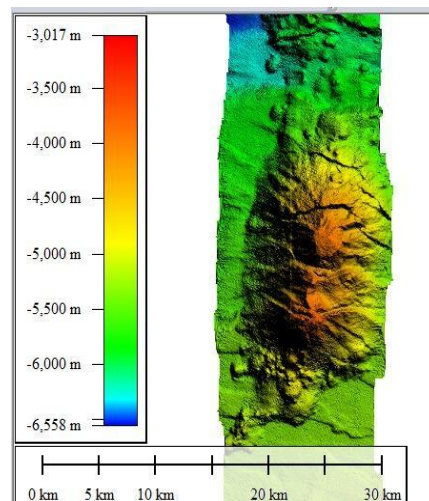


Figure 8. 2D Model of Seabed Topography in the Research Area

Figure 8 can be shown above. The data processing results from *the multibeam echosounder* provide important information about the depth and shape of the seabed topography. Figure 9 shows a three-dimensional (3D) representation of the data that has been processed using *multibeam echosounder technology*. Meanwhile, Figure 9 shows the variation in depth and topography of the seabed that is quite diverse. Using a three-dimensional (3D) model, the process of identifying objects on the bottom of the water becomes easier and clearer.

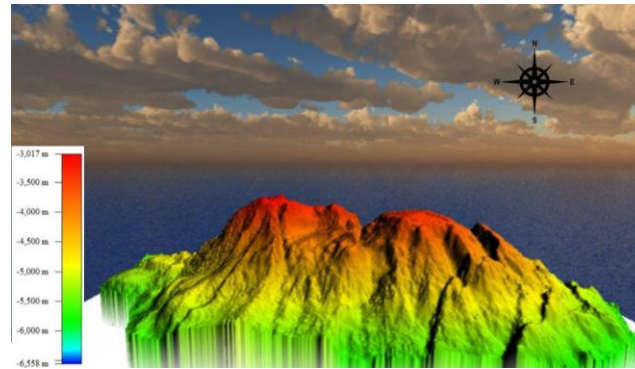
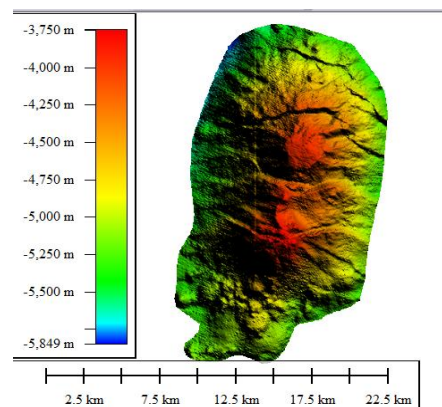


Figure 9. 3D Model of Seabed Topographic in the Research Area

DEM Data Cutting Results and Analysis

DEM data cutting is a selective process to highlight and analyze specific areas in more depth. In this research, DEM cuts were performed to identify significant depth variations in specific areas, with results showing that the deepest area reached -5,849 meters. The color gradations in the DEM map help represent differences in seafloor elevation, so that geomorphological features such as underwater mountains can be recognized more clearly and accurately.



**Figure 10.
Cutting DEM data**

Figure 10 is the result of a *digital elevation model* (DEM) crop that displays underwater morphology on a depth scale. Colour gradations show variations in depth, with red being the shallowest area (-3,750 m), green to yellow being the middle depth (-4,250 to -5,000 m), and dark green to greenish-blue being the deepest area (reaching -5,849 m). The area at the location clipped (24,742.61 hectares) of this pattern indicates the existence of underwater structures such as underwater mountains.

Seamount Results and Analysis

From the processing of this *multibeam* data, it is focused on one object that indicates that the object is an underwater mountain (seamount)

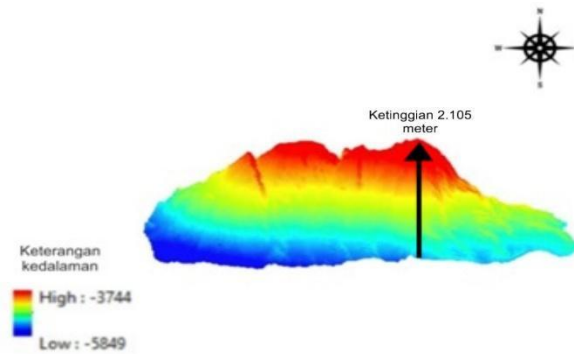


Figure 11. Underwater Mountain Identification

Figure 11 shows a bathymetric model of an underwater feature, with a color scale that shows variations in depth. Red indicates the area with the shallowest depth (-3,744 meters), while blue indicates the deepest area (-5,849 meters). The color gradation from red, orange, yellow, green, to blue describes the change in elevation, where the higher part is at the top of the underwater structure, so that the height of this underwater mountain is about 2,105 meters, because it is calculated from the lowest elevation point, namely at a depth (-5849 m) where the depth shows the foot of the mountain, to the highest point deep (-3744 meters) where it is the top of the mountain. The identification carried out, there is one of the *undersea features*, namely an underwater mountain located in this research area found in the Indonesian continental shelf survey (LKI) in South Java at the coordinates $111^{\circ} 02' 14.39''$ $10^{\circ} 38' 38.40''$, where the survey passed in the lane from October 6 to 9, 2022, underwater mountains can provide a better understanding of the underwater geological processes and the surrounding ecosystems, which can be used for the purposes of scientific research, natural resource exploration, and marine environmental conservation.

The following are the results of the path profile or Transverse Cross-section of the Underwater Mountain (Seamount) to find out the height of the mountain and the width of the mountain which is divided into two transverse cross-sections so that it is very clear in shape.

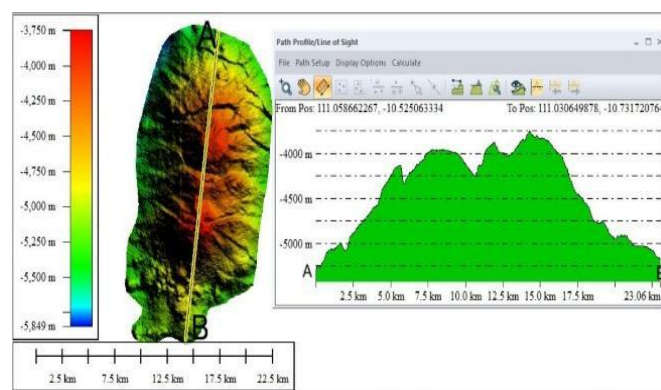


Figure 12. Vertical transverse path or cross-section profile

Figure 12 shows a transverse cross-sectional path profile taken vertically from an underwater mountain based on *digital elevation model* (DEM) data, on the left side shows a color gradation representing depth, where red to orange indicates the shallowest area of about -3,750 meters, while green to blue indicates the deepest area of up to -5,849 meters. The lines

A-B drawn on the map show the path used to generate the transverse elevation profile, which is shown on the right side of the image. This profile depicts variations in seafloor elevation along the trajectory, with several peaks and valleys reflecting the geological structure of the undersea, the seafloor plateau. From this profile, the highest peak that the underwater mountain is at around -3,750 meters, while the deepest seabed in this area reaches -5,849 meters, so the height of this underwater mountain is about 2,099 meters from the surrounding seabed. Analyses like this are essential in the research of marine geomorphology, navigation, as they provide a detailed picture of elevation changes along a given trajectory.

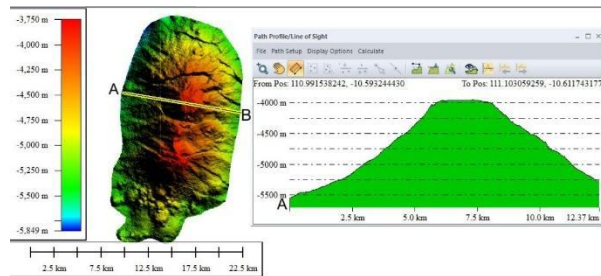


Figure 13. Profile of the transverse path or cross-section

Figure 13 shows the transverse profile analysis of an underwater morphological form shown in a color digital elevation model (DEM) as well as an elevation profile graph. The map on the left shows a variation in depth with a color scale from green to red, where green indicates greater depth, while yellow, orange, and red indicate higher elevation. The AB line on the map represents the path taken to produce the transverse profile on the right-hand graph.

From the transverse profile graph, it can be seen that point A is at a depth of about -5,500 meters, then the topography rises gradually until it reaches the highest peak of about -3,750 meters at a distance of about 7.5 km from the starting point, before descending again towards point B with a depth of close to -5,500 meters at a distance of about 12.37 km. The elevation difference from the bottom to the summit reaches about 1,750 meters, which suggests that this feature constitutes a significant underwater structure, such as an underwater mountain.

And the following is the view of the results of the analysis of underwater mountains which have been made into a bathymetric map as shown in the image below.

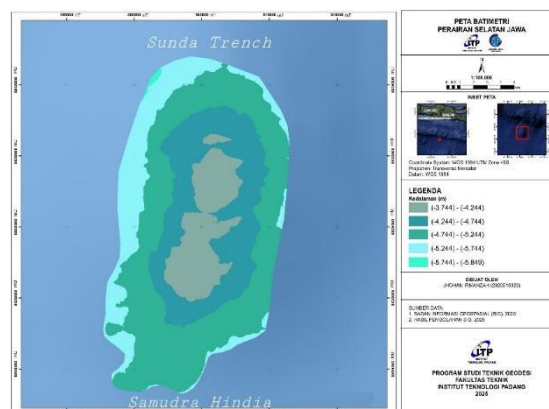


Figure 14. Bathymetric Map

Figure 14 is a bathymetric map which is the result of a seabed morphology analysis in the waters south of Java using *multibeam echosounder* (MBES) data, which allows high-resolution mapping of seabed topography. From the mapping results, it was identified that there was an elevation structure that resembled an underwater mountain, with a depth variation between 3,744 to 5,849 meters. The color gradation on the map indicates a change in depth, where the brightest areas represent shallow depths, while darker areas indicate greater depths. *Multibeam echosounder* (MBES) data is processed using a Geographic Information System (GIS) through filtering, interpolation, and digital *modeling of seabed elevation* to obtain accurate visualization. The existence of these underwater mountains has important implications in the research of marine geology, especially in understanding tectonic dynamics in the subduction zone south of Java, as well as as a potential habitat for deep-sea ecosystems. In addition, this information can be used for the mitigation of geological disasters such as underwater landslides and tsunamis, as well as the exploration of marine resources of strategic value.

Results and Analysis of the slope of the Underwater Mountain (Seamount)

The slope of an underwater mountain or seamount refers to how steep or sloping the slope is around the top of the mountain. The results of this tilt measurement were obtained through seabed topographic data obtained using multibeam echosounder technology . With this data, it can produce a tilt map that depicts variations in slope angles in various parts of the seabed, from the summit to the deeper seabed.

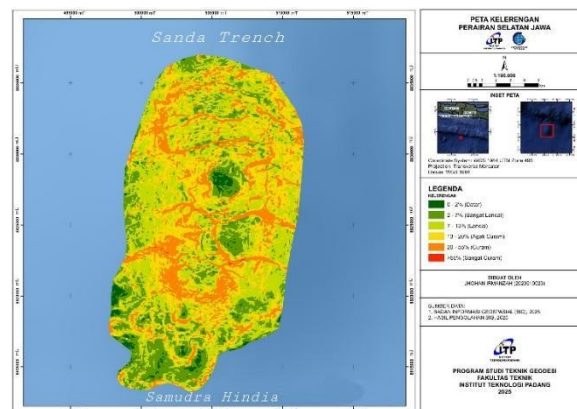


Figure 15. Map of the Slopes

In figure 15 this is the result of data processing and data processing. This map of the slope illustrates how the seabed surface in the waters south of Java has different slope variations and according to the division of the slope ranging from flat to very steep areas. Where in the flat area has an area of 518.37 hectares, very sloping 4,488.46 hectares, slope 8,420.1 hectares, slightly steep 6,985.66 hectares, steep 4,314.83 hectares and very steep 15.18 hectares.

Table 1 Slope of underwater mountain slopes

Slope (%)	Information	Area (ha)
0-2	Flat	518,37
2-7	Very sloping	4.488,46

<i>Slope (%)</i>	Information	Area (ha)
7-13	Ramps	8.420,1
13-20	A bit steep	6.985,66
20-55	Steep	4.314,83
>55	Very steep	15,18

Results and Contour Analysis of Seamount

The contour map used is 2 contours, namely minor and major where minor with an interval of 100 meters and major 500 meters of complex seabed topographic variations. Contours with depths of -3,744 to -5,849 meters indicate a significant change in elevation over short distances, which is characteristic of underwater mountains.

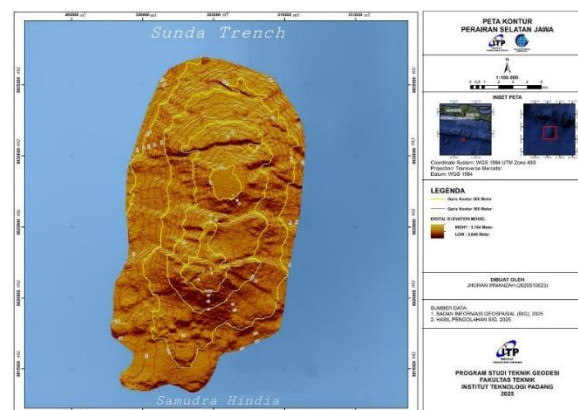


Figure 16. Minor and major contour maps

In figure 16, a contour with a depth between -3,744 meters to -5,849 meters can be seen giving a clear picture of the variation in the seabed topography in the area studied. With the contour intervals of 100 meters and 500 meters, it can be clearly seen that there is a significant difference in depth at various points. The contour map shows a clear variation in the depth of the seabed. There are several parts with relatively stable depths. However, some sharper and steeper topographic features were also found, indicating a more significant difference in depth over short distances.

IHO Standard *Vertical Total Uncertainty* (TVU) Correction

The following are the results of the *Total Vertical Uncertainty* (TVU) correction, which measures the uncertainty of sea depth measurement according to the IHO standard (S-44). TVU is important to ensure the accuracy of hydrographic surveys.

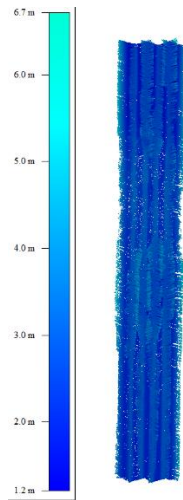


Figure 17. IHO Standard Vertical Total Uncertainty (TVU) Correction

In Figure 17, In hydrographic surveys, the accuracy of depth data is highly dependent on the level of vertical *uncertainty* (TVU), which must meet the IHO S-44 standard in order for the measurement results to be used accurately. In this research, depth measurements were in the range of 3,017 meters to 6,558 meters, so corrections to the TVU value are very important to ensure the reliability of the data.

TVU is calculated using the formula:

$$TVU_{max}(d) = \pm \sqrt{a^2 + (b \times d)^2} \quad (1)$$

Information:

TVU_{max}	=	Total Vertical Uncertainty with $\pm$ results Stated values
a	=	Independent errors (fixed number of errors)
b	=	Dependent depth error factor (number of errors that are not fixed)
d	=	Measured depth
(W x D)	=	Depth dependent errors.

Where a is a fixed error component that reflects the technical factors of the measurement system, while b is an error component that depends on the depth d being measured. Based on the IHO S-44 standard, for the Order 1a and 1b surveys, the value of a is 0.5 meters, while b has a value of 0.013.

By applying the formula at a minimum depth of 3,017 meters, the following values were obtained:

$$TVU_{max}(d) = \pm \sqrt{0,5^2 + (0,013 \times 3.017)^2} = 0,521 \text{ meter}$$

Meanwhile, at a maximum depth of 6,558 meters, the calculated TVU value is:

$$TVU_{max}(d) = \pm \sqrt{0,5^2 + (0,013 \times 6.558)^2} = 0,555 \text{ meter}$$

These results show that the vertical uncertainty in this survey is still within the tolerance limit for Order 1b, which allows this data to be used for bathymetric mapping, analysis of seabed morphology such as underwater mountains.

Based on the results of the measurement and analysis of the TVU correction, the actual vertical uncertainty range of 1.2 meters to 6.7 meters was obtained. This range shows that the deeper an area is measured, the greater the vertical uncertainty obtained, in accordance with the pattern of uncertainty recognized in hydrographic surveys. For depths of more than 6,000 meters, the value of the TVU which ranges from 6.7 meters is still in accordance with the hydrographic survey tolerance in the IHO standard, especially for Order 1b, which is still acceptable in detailed bathymetric mapping.

These results show that the vertical uncertainty in this survey is still within the permissible tolerance limit for Order 1b, which allows this data to be used for various purposes of bathymetric mapping, seafloor morphology analysis, and marine geospatial research. Thus, this analysis confirms that TVU corrections are indispensable to ensure that the quality of the data remains consistent with international standards, reduce the potential for misinterpretation, and improve the accuracy of the hydrographic survey results that will be used in further studies.

IHO Standard *Total Horizontal Uncertainty* (TVU) Correction

Based on the results of the correction of total horizontal uncertainty (THU) measures uncertainty in the measurement of sea depth, and in accordance with the IHO standard (S-44), the total horizontal uncertainty (THU) includes a variety of uncertainty factors that can affect the results of these measurements are essential to ensure the accuracy of the hydrographic survey

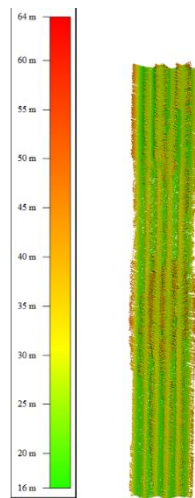


Figure 18. IHO Standard Vertical Total Uncertainty (TVU) Correction

In figure 18, Total Horizontal Uncertainty (THU) is one of the important parameters in a hydrographic survey that determines the level of accuracy of the position of a measurement point on the seabed. High THU can affect the quality of bathymetric data, navigation, and marine geospatial mapping. In this survey, the depth measured ranged from 3,017 meters to 6,558 meters, with the THU value obtained being in the range of 16 meters to 64 meters. To determine whether the THU value is still within the tolerance limit set by the International Hydrographic Organization (IHO) S-44, the calculation is carried out using the formula:

$$THU_{max}(d) = \pm \sqrt{C^2 + (d \times e)^2} \quad (2)$$

Where C is the fixed error component in the measurement system, e is the horizontal uncertainty factor that depends on the depth d , and d is the depth in meters. Based on the IHO S-44 standard for Orders 1a and 1b, the value of C is set at 5 meters, while e is valued at 0.023. By applying this formula to the depth of the survey, the following calculations were obtained:

At a depth of 3.017 meters:

$$\begin{aligned} THU_{max}(3.017) &= \pm\sqrt{5^2 + (3.017 \times 0,023)^2} \\ &= \pm\sqrt{25 + 0,0048} \\ &= \pm\sqrt{25.0048} \approx \pm 5,00 \text{ METER} \end{aligned}$$

At a depth of 6.558 meters:

$$\begin{aligned} THU_{max}(6.558) &= \pm\sqrt{5^2 + (6.558 \times 0,023)^2} \\ &= \pm\sqrt{25 + 0,0227} \\ &= \pm\sqrt{25.0227} \approx \pm 5,00 \text{ METER} \end{aligned}$$

The results of this calculation show that the theoretical THU value based on the IHO standard should be around 5 meters, while from the actual survey results, the THU value obtained is much larger, which is in the range of 16 meters to 64 meters. This value indicates that the survey conducted has a higher horizontal uncertainty compared to the tolerance set for surveys with a high level of accuracy such as Order 1a and 1b. Based on IHO standards, surveys with THU in the range of 16 meters to 64 meters are closer to the characteristics of Order 2 surveys, which are generally used for lower-precision mapping or seabed exploration studies.

Thus, it can be concluded that the horizontal uncertainty obtained in this survey is quite high, so if this data is going to be used for needs that require high accuracy, further correction is needed. Some of the efforts that can be made to improve the accuracy of the results are by improving the navigation system, increasing the resolution of the measurement sensor, and further calibrating the survey equipment used. However, the data obtained can still be used for seafloor mapping, underwater morphological analysis, and maritime geospatial studies that do not require a very high level of accuracy

CONCLUSION

This research succeeded in identifying underwater mountains in the waters south of Java using Multibeam Echosounder (MBES) data, which allows for a more detailed visualization of the seabed topography. The peak of the underwater mountain is found at a depth of -3,744 meters with a base of -5,849 meters, so it has an altitude of about 2,105 meters. The cut-off of DEM data helps highlight significant variations in depth, while slope slope analysis shows the presence of steep zones that have the potential for sediment instability. The contour map produced depicts the topographic complexity of the seabed, while the Total Vertical Uncertainty (TVU) correction ensures the accuracy of bathymetric data according to the IHO S-44 standard in the Order 1b category. Future research contributions should focus on: (1) conducting detailed geological sampling to understand the formation and age of the identified seamount, (2) investigating the biological communities associated with this underwater mountain to support marine conservation efforts, (3) extending the survey area to map additional seamounts in the region, and (4) integrating this data with existing geological models to better understand the tectonic evolution of the Java subduction zone.

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