

SeafloorAI: A Large-scale Vision-Language Dataset for Seafloor Geological Survey

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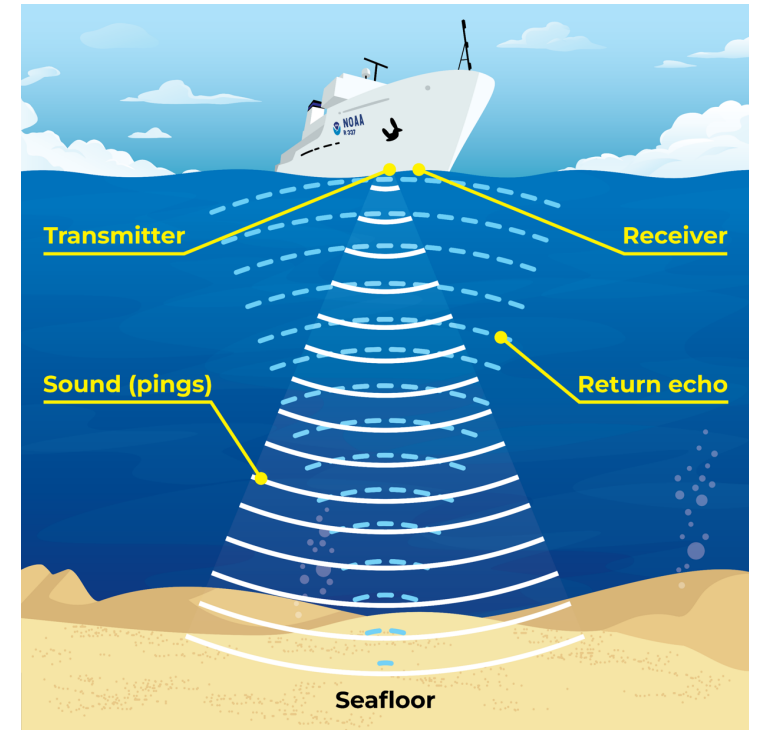
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What is Seafloor Mapping?

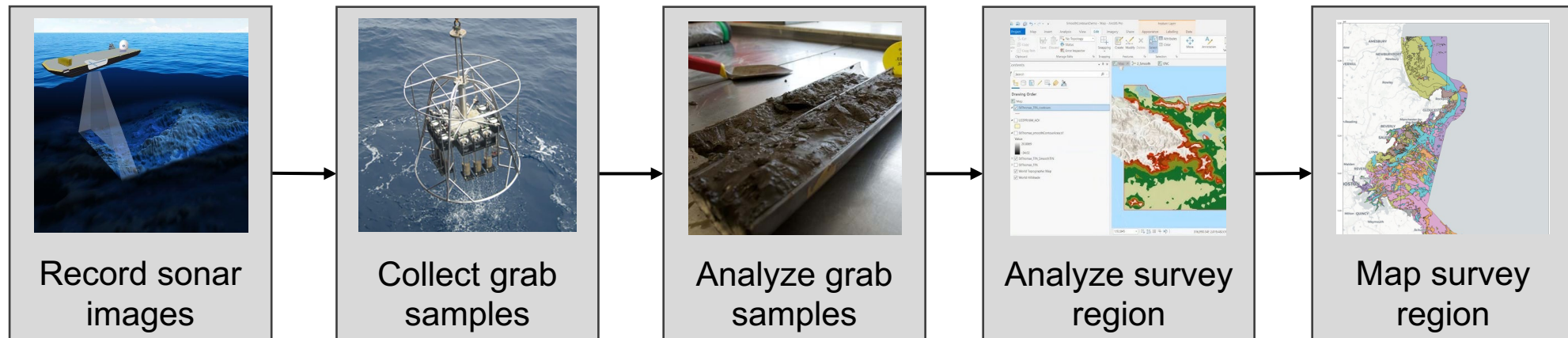
- The process of measuring and visualizing the topography, composition and habitat of the ocean floor.
- Utilizes technologies like multibeam echosounders and side-scan sonar to unveil the complexities of the seabed.
- Benefits *high-impact* end-user applications, such as marine debris detection, offshore wind development, etc.



How sonar images are recorded.
Image courtesy of NOAA.

The Current State of Seafloor Analysis

- Current analysis techniques are labor-intensive and reliant on manual interpretation.
 - Time-consuming
 - User subjectivity due to individual expertise
 - Introduces inconsistencies in the process

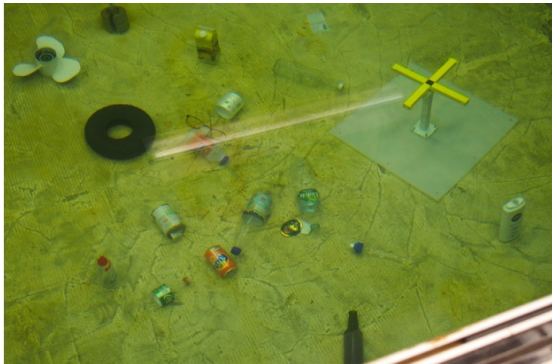


➤ The integration of machine learning holds the promise of enhancing the analysis process.

The Current State of AI-Ready Seafloor Datasets

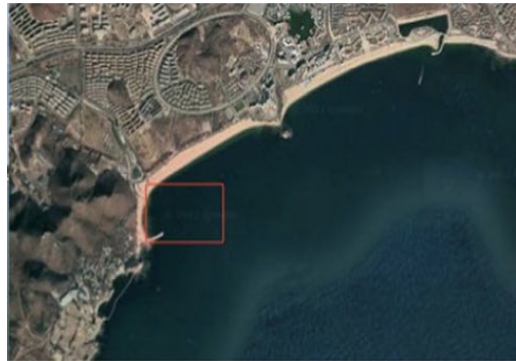
Existing seafloor datasets are limited in terms of environmental setting and scale.

Unrealistic Environment Setting



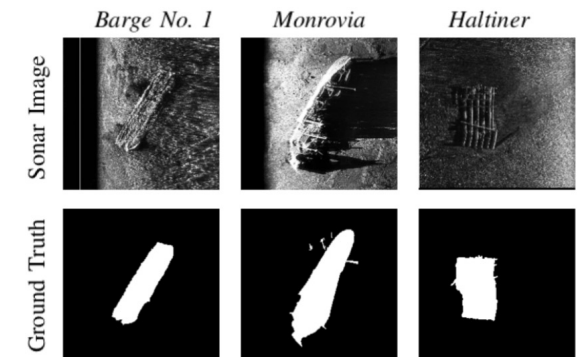
Singh and Valdenegro-Toro [1] captures sonar dataset in a water tank.

Limited Area Coverage & Locations



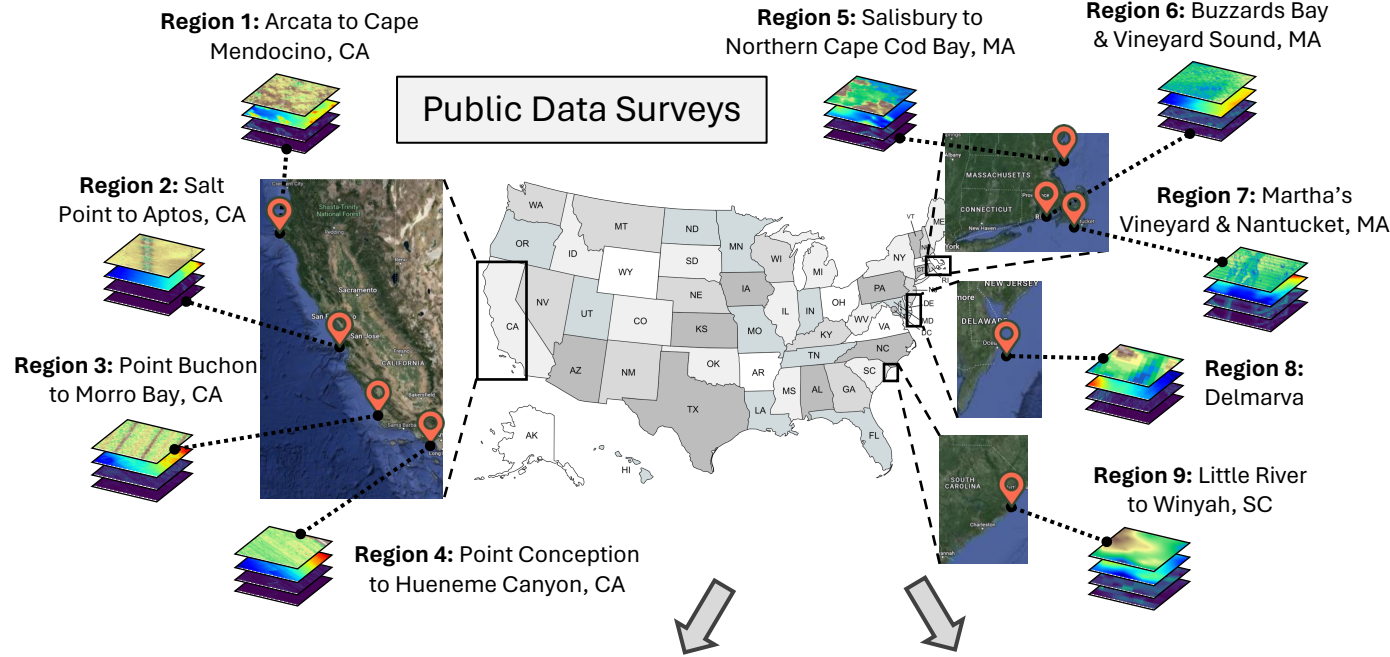
Luo et al. [2] collects data from a single location.

Small-scale dataset



Sethuraman et al. [3] collects a shipwreck dataset with only 286 sonar images.

The First Large-scale AI-ready Seafloor Dataset



Survey Statistics

# of surveys	62
# of regions	9
# of geographic layers	9
Total coverage area	17,300 km ²

Image Data

# of samples	696.5K
Image size	224 × 224
Pixel resolution	1m to 10m

Annotation Details

# of segment masks	827.2K
# of text descriptions	696.5K
# of text instructions	approx. 7M

SeafloorAI Dataset

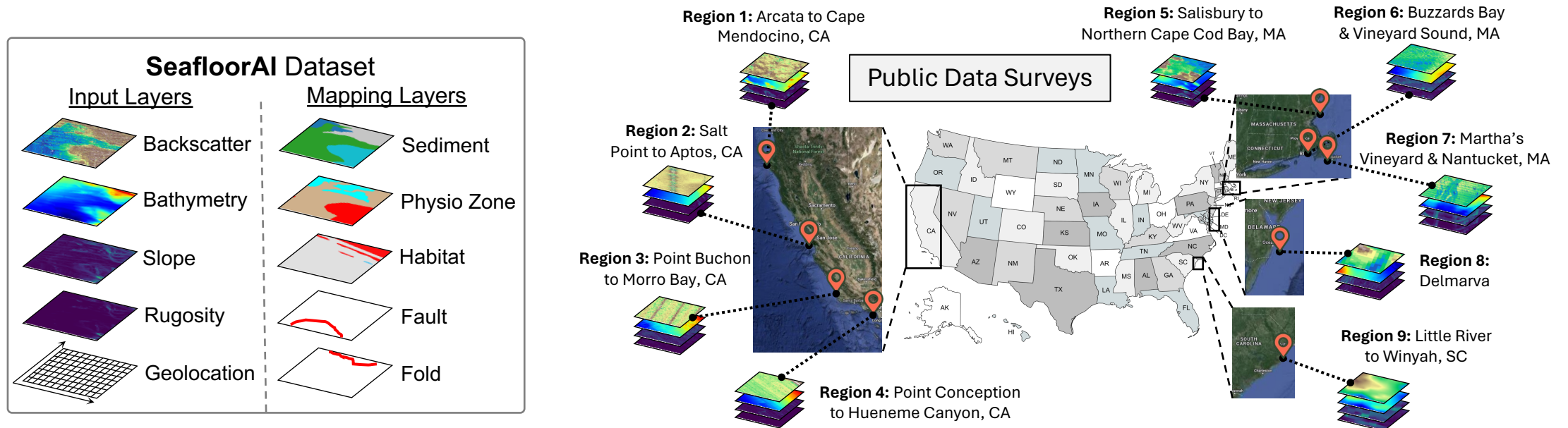
Input Layers	Mapping Layers
Backscatter	Sediment
Bathymetry	Physio Zone
Slope	Habitat
Rugosity	Fault
Geolocation	Fold

SeafloorGenAI Dataset

 USER: What types of <u>sediment</u> are depicted in this sonar image?	 USER: What <u>physiographic zones</u> are in the image? Please segment them.
 ASSISTANT: There are four different sediment types in the sonar image: Muddy Sand (45%) , Gravelly Sand (11%) , Gravelly Rock (19%) , and Muddy Rock (25%) .	 ASSISTANT: There are three different physiographic zones types in the image: Continental Shelf <SEG> , Continental Shore Complex <SEG> and Shelf Basin <SEG> .

General VQA Capability Instruction-following Segmentation

SeafloorAI: From Public Data to AI-Ready Dataset



We compile **62** public USGS and NOAA hydrographic data surveys to construct the **SeafloorAI** dataset.

- Covers an area of **17,300 km²**
- Distributes across **9** regions
- Supports **9** geological layers
- Contains **696K** sonar images
- **827K** expert-annotated segmentation masks
- Supports **5** seafloor mapping applications

From Public Data to AI-Ready Dataset

Problem: Naming convention for geological attributes is **not uniform**

Illustration of inconsistency in naming conventions in the Sediment layer.

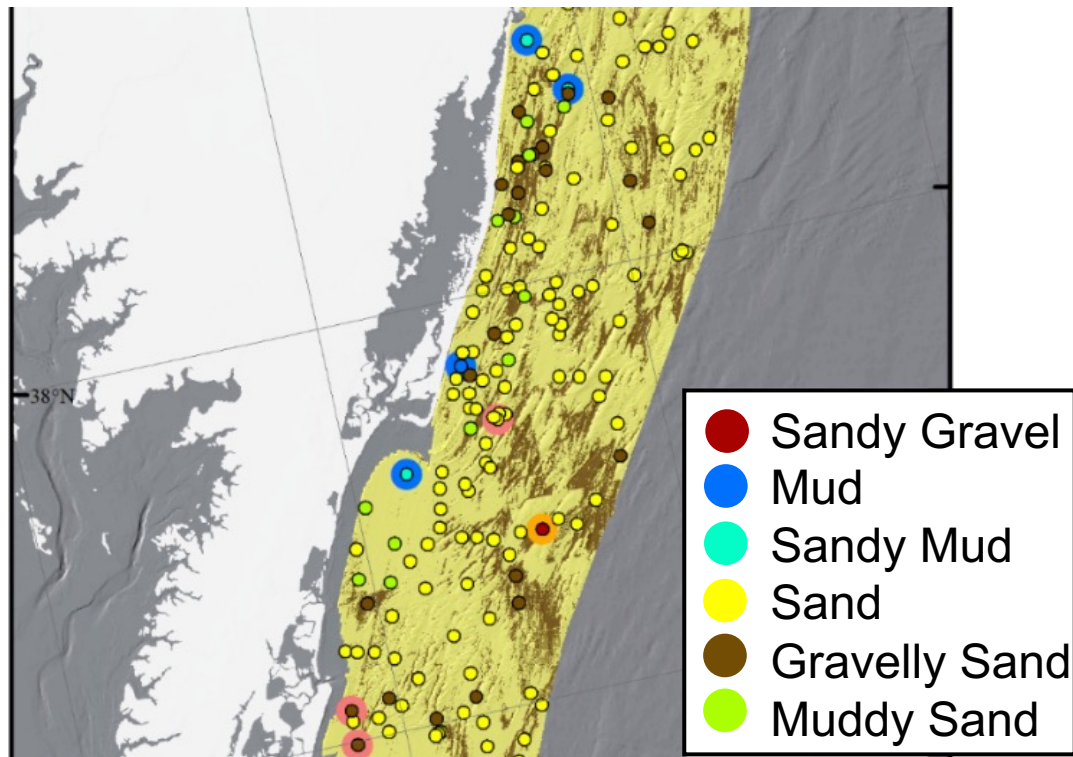


Figure adapted from Pendleton et al. [4]

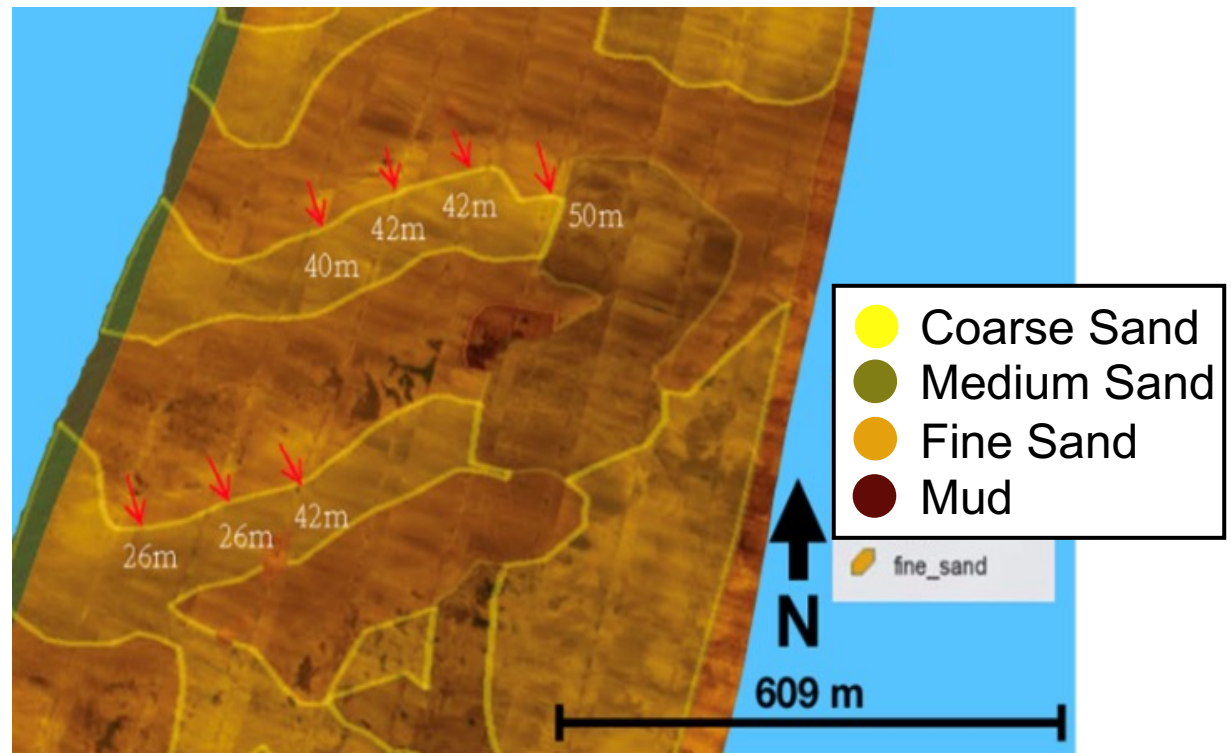
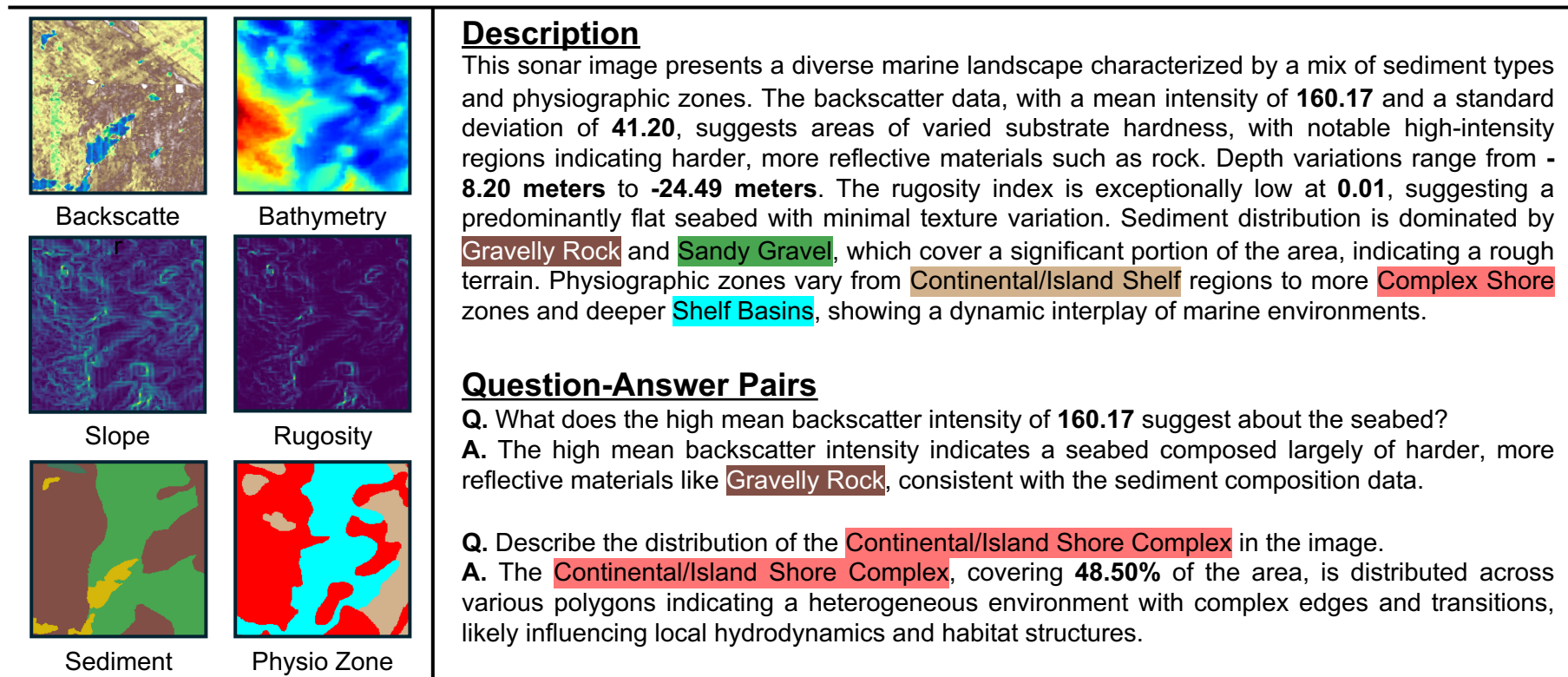


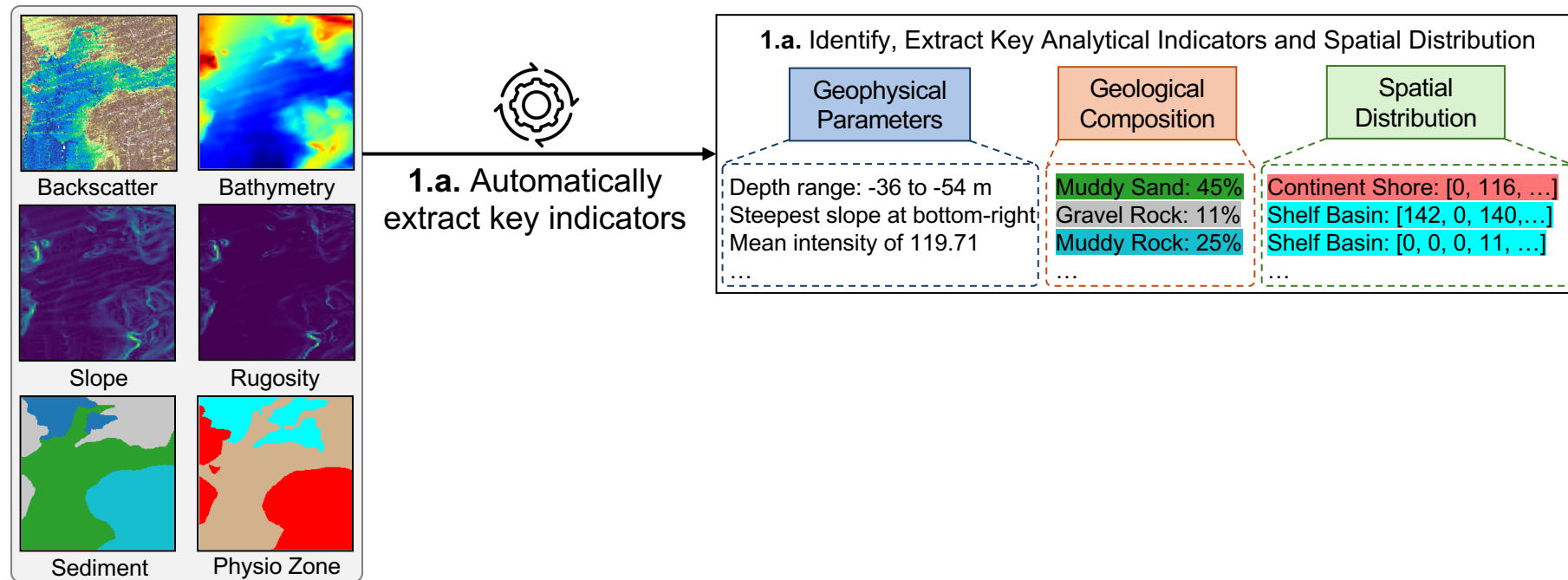
Figure adapted from Trembanis et al. [5]

SeafloorGenAI: Creating Language Annotations

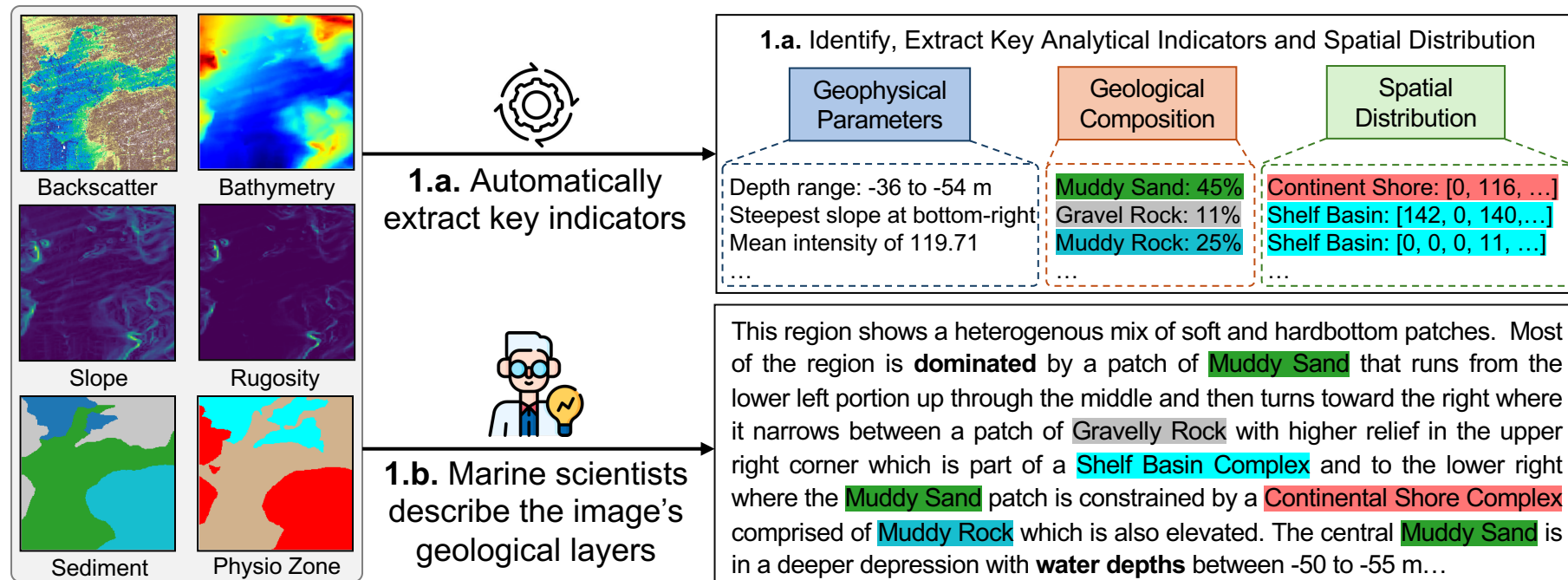
- **SeafloorGenAI** incorporates vision and language understanding via image captioning and visual question answering (VQA), facilitating the advancement of large vision-language models in the marine science field.
- We leverage GPT-4 to generate language annotations with domain knowledge injected.



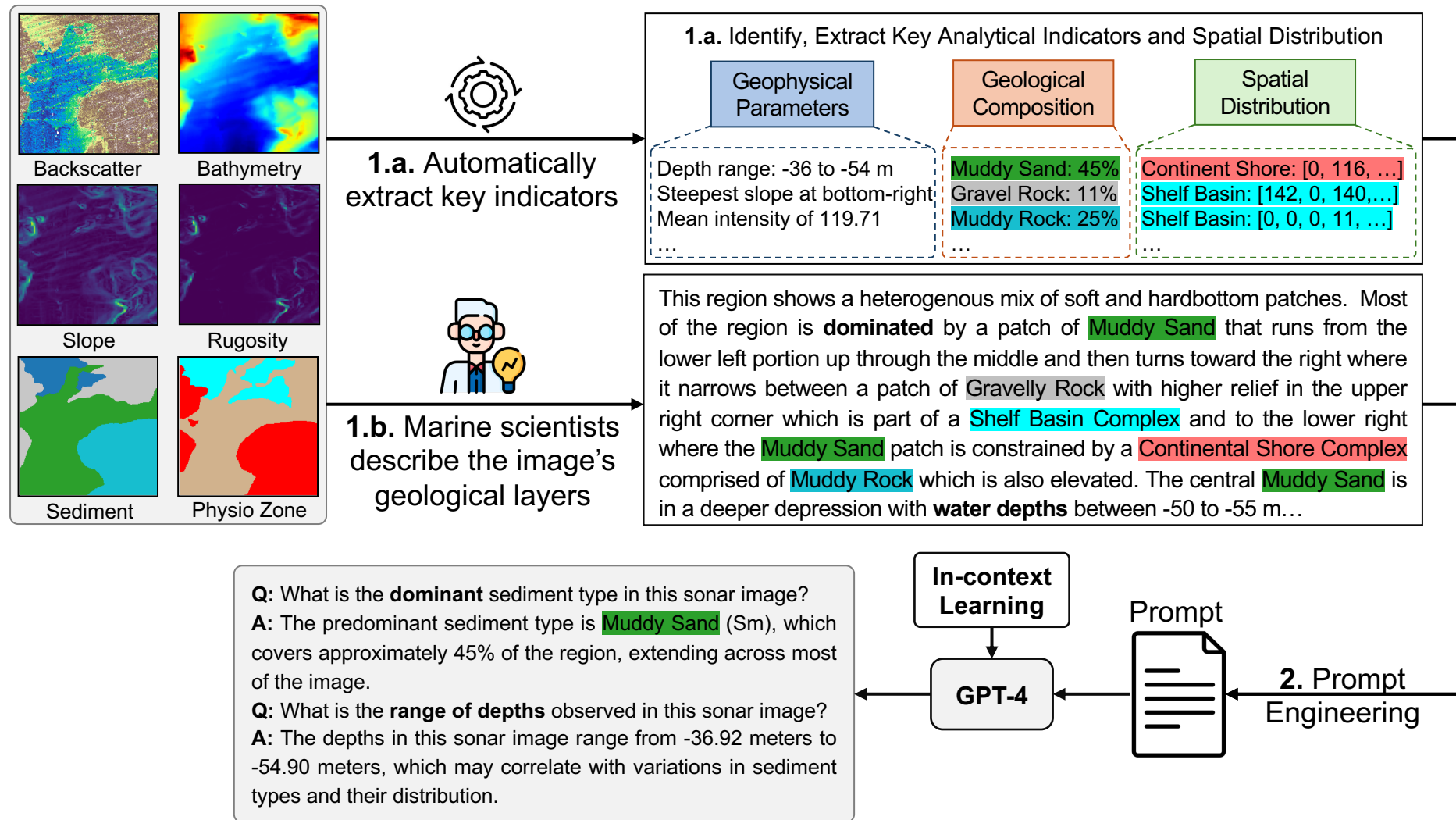
Marine Scientists Help AI Annotate Data



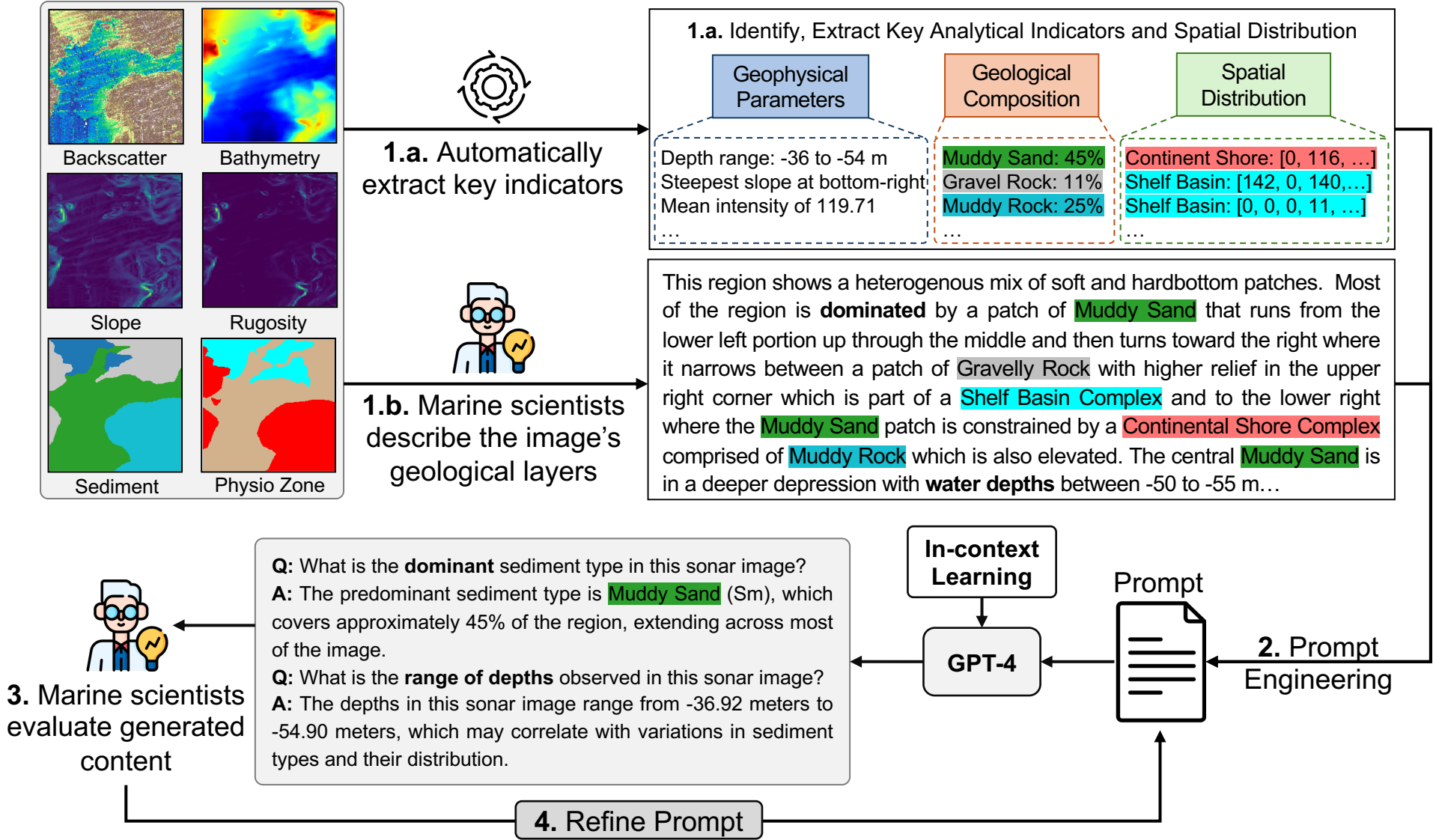
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Thank You For Listening!

