GPH 444

Marine Geophysics

(Unit 6)

Learning Objectives

By the end of unit (6) you should be able to recognize:

1. Magnetic prospecting.
2. The use of magnetometers.
3. Concept of marine magnetometers.
4. The use of magnetometers.
5. Application of marine magnetometers.

Magnetic prospecting

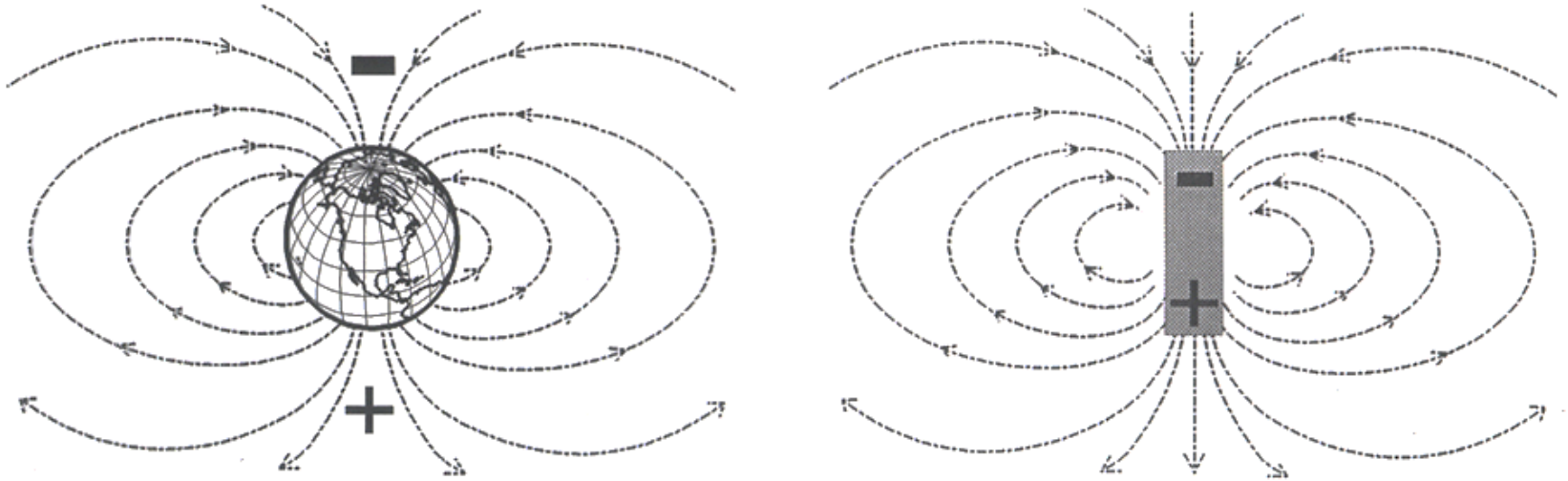
- Magnetic prospecting is used to explore for both oil and minerals.

- It gives information to determine depth to basement rocks, locate and define the extent of sedimentary basins. This information is of importance in previously unexplored areas such as continental shelves newly opened for prospecting.

- Sedimentary rocks exert a very small magnetic effect compared to igneous rocks.

- Virtually all variations in magnetic intensity result from topographical or lithlogic changes associated with the basement or from igneous intrusive.
- Today, all magnetic surveys are done from air or from ships due to speed, economy and convenience.

The earth's magnetic field is similar to that produced by a simple bar magnet placed in the center of the earth. The magnetic lines get into the earth from the north pole, and get out of it from the south pole. Thus the positive end of the bar magnet points to the south, and vice versa.



a) Earth

b) Bar Magnet

Introduction:

Magnetometers measure minor differences in the strength of the Earth's magnetic field.

Most sedimentary rocks are nearly non-magnetic (although some sedimentary rocks such as sandstones can have local concentrations of magnetic minerals such as magnetite).

Igneous rocks generally have a stronger magnetic effect.

Because of these different effects on the magnetic field, measurements can be made to work out the vertical thicknesses and lateral distribution of rock units.

Introduction:

In general, rocks containing magnetic minerals such as magnetite have greater magnetic susceptibility and therefore produce more intense magnetic readings.

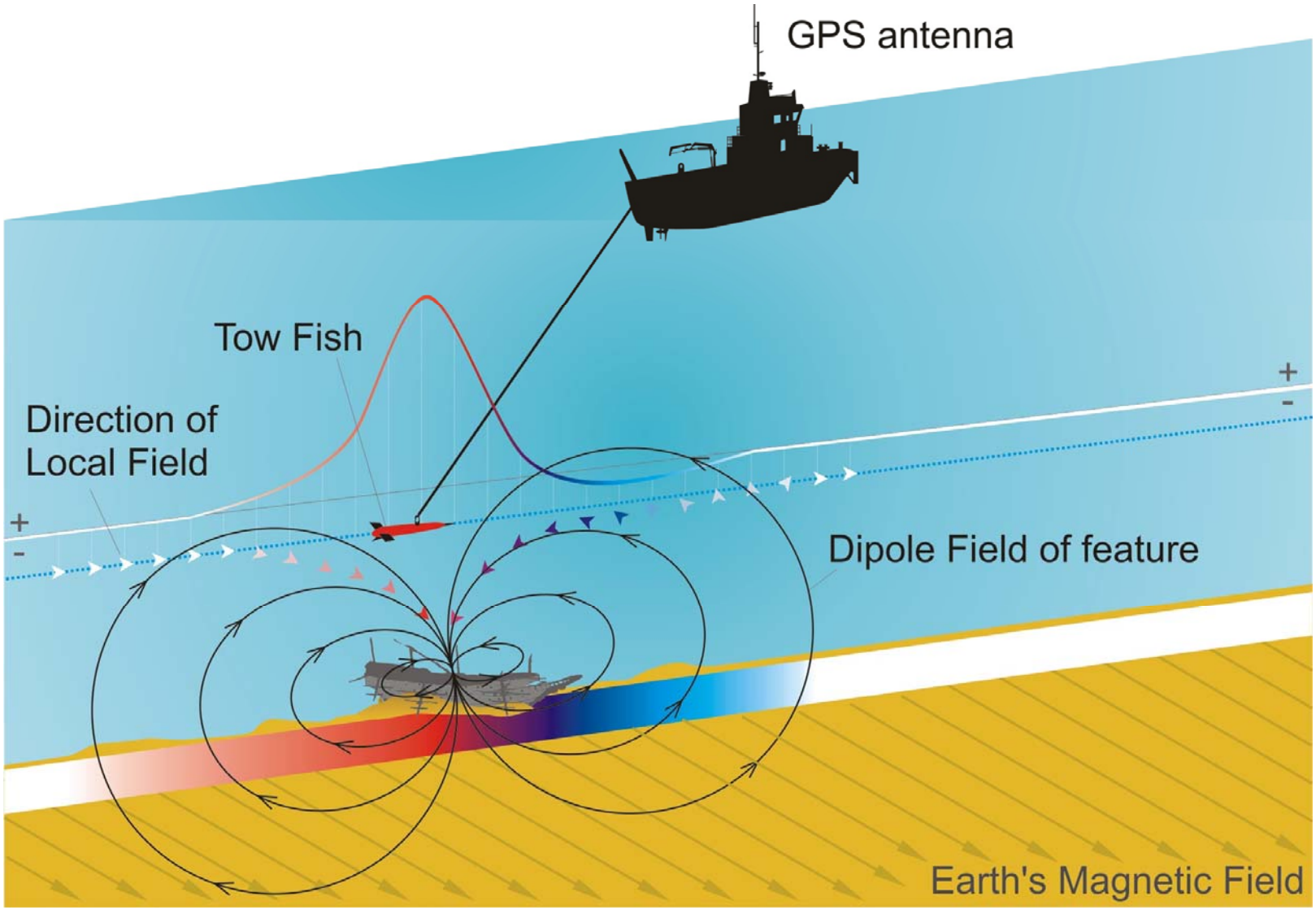
Major ore deposits (especially iron-bearing units) have been discovered with magnetometers.

A mass of iron locally intensifies the earth's natural magnetic field. Magnetometers, installed in airplanes and boats, are routinely used in geophysical surveys.

The location of large iron-rich objects, such as sunken ships, can be accomplished using magnetometers.

Marine Magnetometers:

A magnetometer is an instrument which measures the intensity of a magnetic field. Their application in geophysical prospection is founded on the principle that they can measure and record deviations in the Earth's ambient magnetic field brought about by the presence of ferromagnetic material.


GPS antenna
Tow Fish
Direction of
Local Field
+
-
+
-
Dipole Field of feature
Earth's Magnetic Field

Marine Magnetometers:

- Detect smaller targets farther away.
- Define smaller targets at higher survey speeds.
- Survey in areas with large steel anomalies and perform instrument checks on deck prior to survey.
- Better able to define large anomalies.
- Excellent performance for all applications, from small object detection to large geologic surveys.
- Magnetometer data can be used to map buried channels.
- Relative simple and cheap method.

Sea Floor Mapping:

Positioning: GPS, INS, …

Bathimetry: Multi-beam, single beam.

Imagery: Side Scan Sonar , SHADOWS (SAS).

Sub-Bottom Mapping:

Sub-bottom profiler.

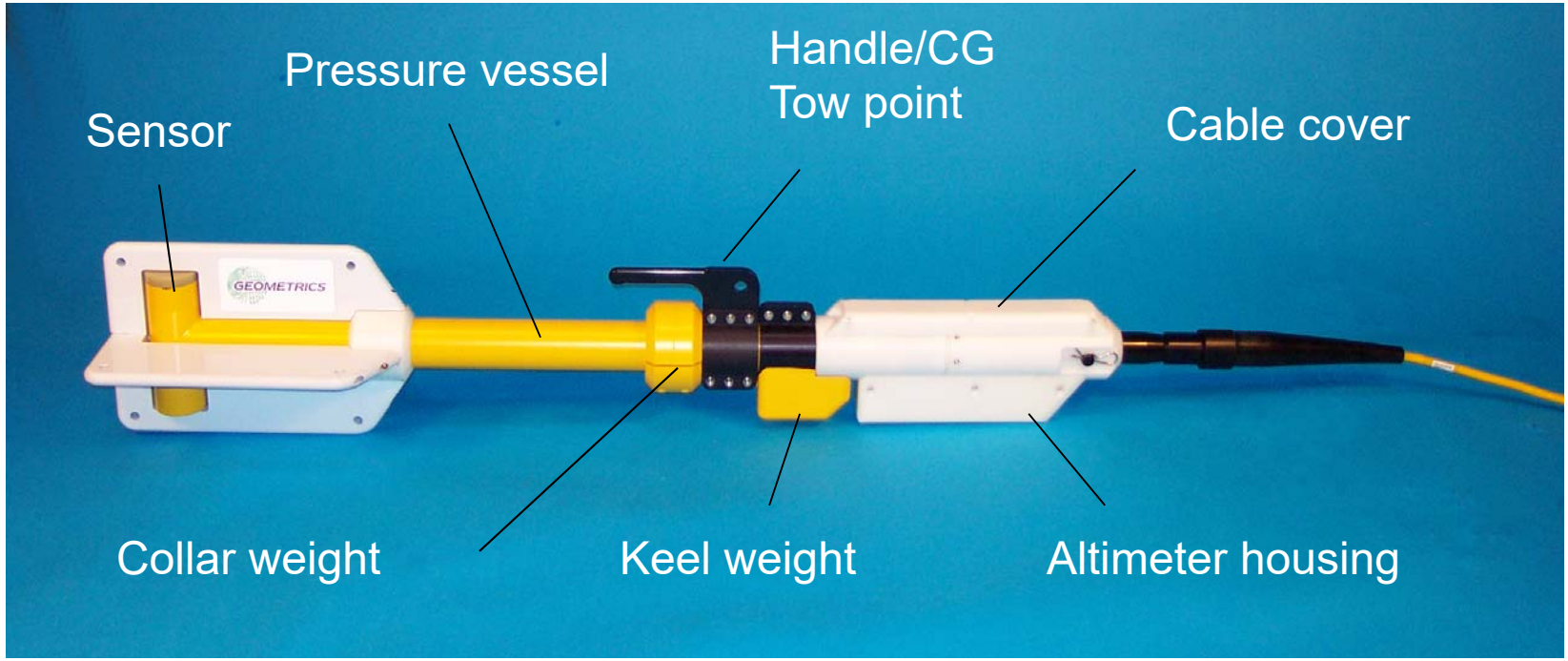
Magnetometer, gradiometer, UXO survey.

Electro-magnetism.

Explorer Is Ideal For:

- Inshore, shallow water work.
- Offshore towed behind side scans, AUVs and ROVs.
- Inshore geophysical survey.
- Archeology.
- Wreck detention.
- Magnetic mapping of harbors.
- Ferrous target detection in lakes, rivers and estuaries.

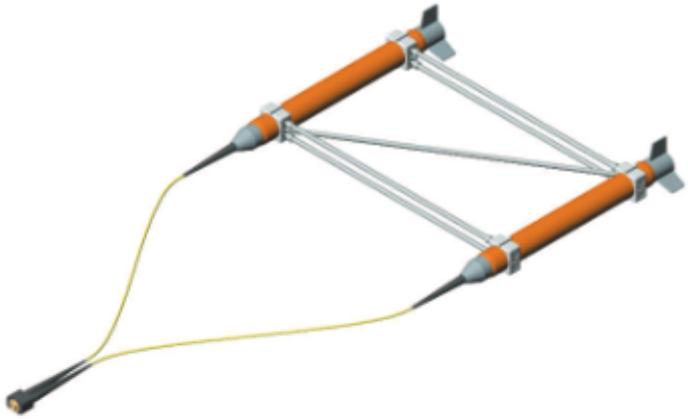
Marine Magnetometers:



Marine Magnetics offers each of these gradiometer configurations. In addition, all SeaSPY magnetometers are compatible, enabling existing SeaSPY customers to upgrade their magnetometer to the gradiometer configuration of their choice, as they need to.

Horizontal or Vertical Transverse Gradiometer

Marine Magnetics' transverse gradiometers provide a rigid 2m structure linking the sensors, and are well suited for close-in precision surveys for small ferrous targets where short sensor separation is needed.



Applications

Cable and Pipeline Survey – A horizontal transverse gradiometer can be used to track cables, or pipelines in real time from relatively high towing altitudes.

Detection of Small Ferrous Targets – Short baseline gradient measurement in any direction (longitudinal, horizontal, or vertical) is useful for eliminating geological interference and diurnal variation.

Longitudinal Gradiometer

Longitudinal gradiometers provide the largest variation in available baselines, from 1.5m to 500m+. Again, Marine Magnetics' communication transceiver technology is unmatched in its ability to support extremely long distances between the two towfish. Long baselines provide superior gradient measurement sensitivity and increased detection range. Longitudinal gradiometers are also extremely hydrodynamically stable when deployed.

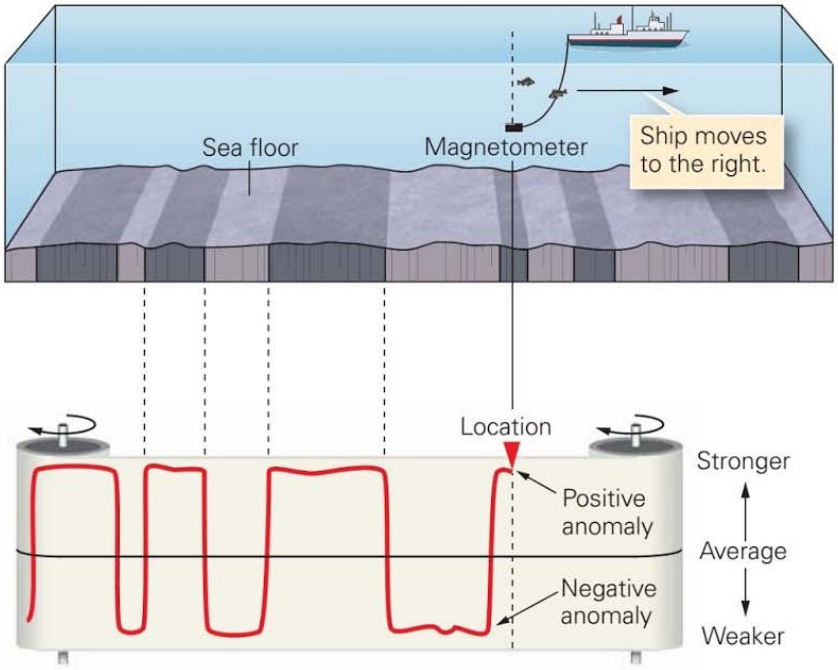
Applications

Shipwreck, Search and Salvage – Medium baseline longitudinal gradient measurement can eliminate interference by geological bodies, while highlighting massive magnetic sources like steel hulls, boilers or engines. Smaller sources such as anchors or cannons will require a shorter baseline, and lower towing altitude.

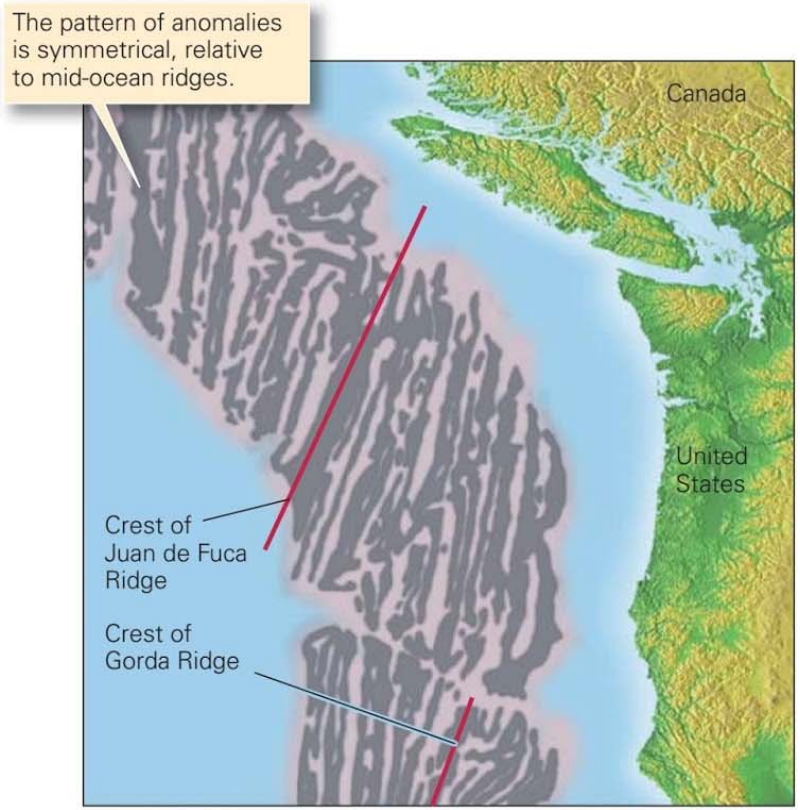
Environmental Survey – Medium baseline measurement with a longitudinal gradiometer can highlight shallow magnetic sediments, while eliminating deeper geological influences. The baseline should be on the order of magnitude of the expected towing altitude.

Exploration Geophysics – Long-baseline measurement with a longitudinal gradiometer is ideal since the bodies of interest are often far from the sensor, and produce very small gradients. The baseline should be on the order of magnitude of expected depth-to-source.

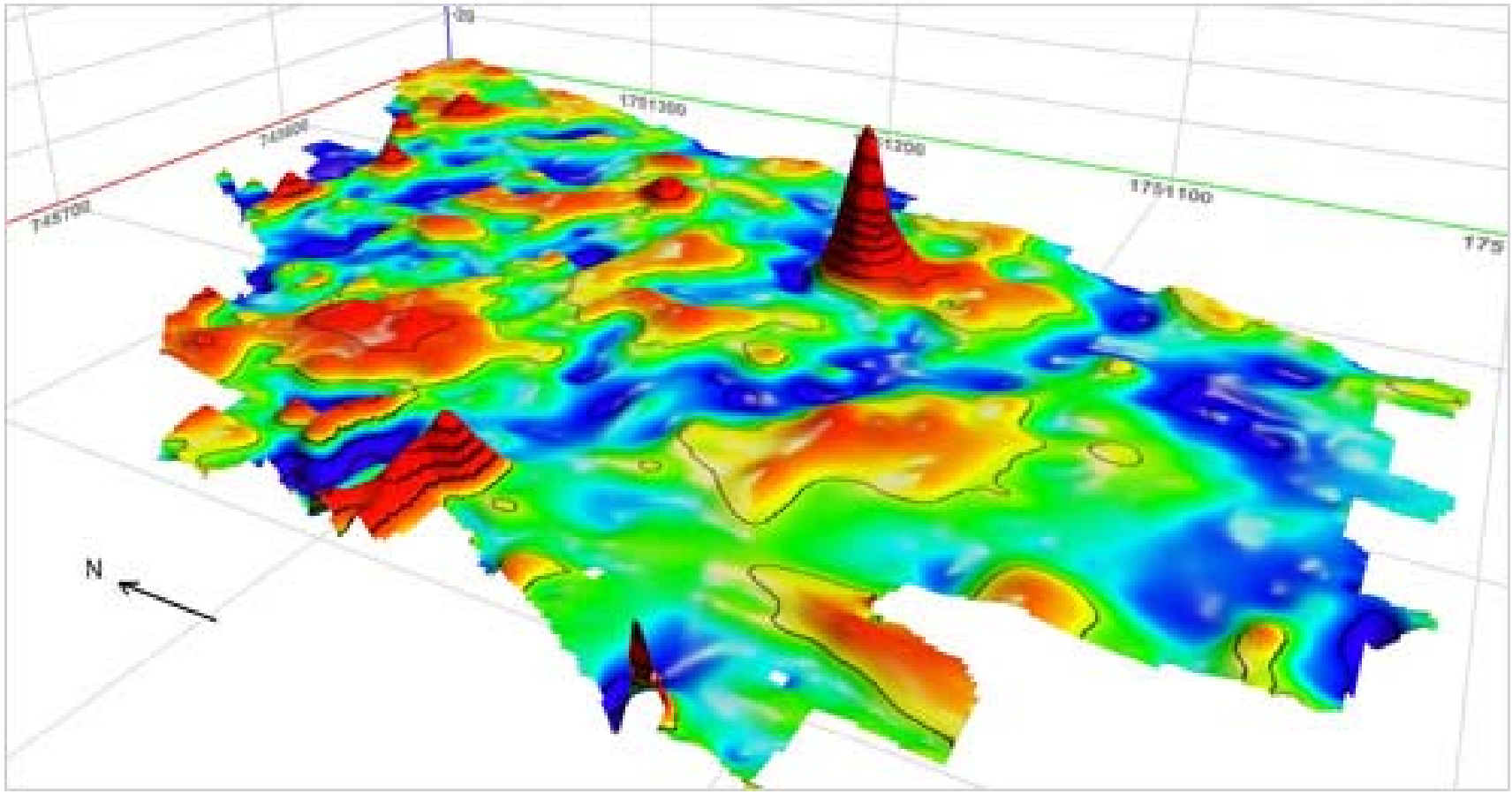
(a) A ship towing a magnetometer detects changes in the strength of the magnetic field.



(b) On a paper record, intervals of stronger magnetism (positive anomalies) alternate with intervals of weaker magnetism (negative anomalies).



(c) A map showing areas of positive anomalies (dark) and negative anomalies (light) off the west coast of North America. The pattern of anomalies resembles candy-cane strips.



GPH 444: Unit 6 (Marine Magnetometers)