

Oceanography

A View of the Earth 5th edition

M. Grant Gross

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A View of the Earth

FIFTH EDITION

M. Grant Gross



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History of Oceanography

OBJECTIVES

1. To grasp the role of the ocean in human history;
 2. To understand the development of ocean science;
 3. To understand the importance of technological advances in ocean science;
 4. To recognize and understand recent changes in the legal status of the ocean.
-

Oceanography—scientific study of the ocean—is a modern activity, but dealing with the ocean has been important in people’s daily lives for many centuries. Sailors and traders explored the ocean and its shores, looking for new lands to settle, new trade routes to ply, or new products to buy and sell. Most of these discoveries were not recorded, in part because they were much too valuable to share.

Today, oceanographers study the ocean (Fig. 1-1) to develop better ways to predict the behavior of weather systems, such as the monsoons (heavy summer rains) which are necessary for growing rice in India and Southeast Asia, to devise methods to extract more food from the sea, or to find new sources for minerals or oil and gas on the ocean bottom. As we learn more about our nearby neighbors and the Earth’s moon, we see what a unique feature the ocean is (Fig. 1-2, Fig. 1-3).

In short knowing how the ocean works, permits us to improve and protect our lives in many ways. In this chapter, we discuss:

FIGURE 1-1

Seen from space, Earth is a blue sphere (ocean) with clouds (white areas) covering more than half its surface. Land is scarce in this southern hemisphere view. Desert areas of Africa are rust colored. The ice-covered Antarctic continent (white) is at bottom center. (Courtesy NASA.)



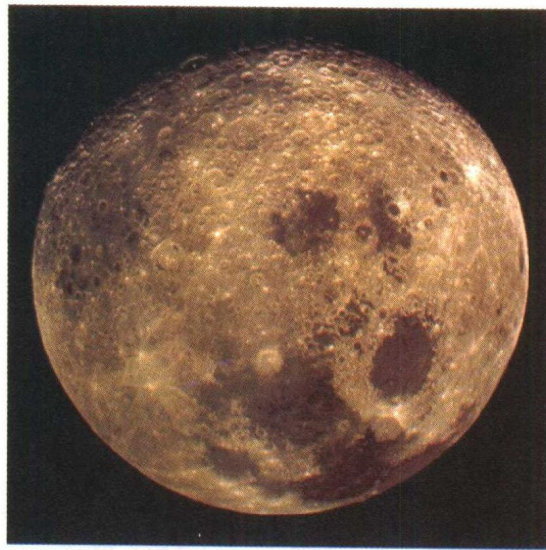


FIGURE 1-2

The Moon's surface shows scars from numerous meteorite impacts over its 4.5 billion years of existence. There is no water to erode such features and its crust is not recycled by mountain building as it is on Earth. (Courtesy NASA.)

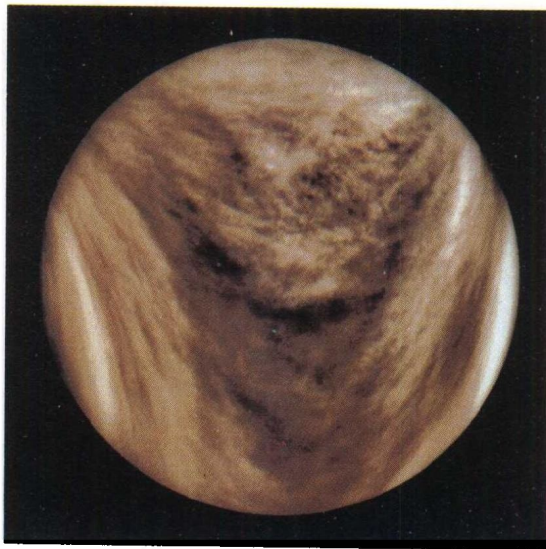


FIGURE 1-3

The surface of Venus is obscured by dense clouds of water vapor, sulfuric acid and carbon dioxide. While Venus resembles Earth in many ways, its history is markedly different from Earth's where the water has collected in ocean basins and most of the carbon dioxide is deposited as limestones or organic carbon. We do not know if there is mountain building on Venus. (Courtesy NASA.)

The ocean's role in human history;
History of ocean studies;
Uses of ocean sciences in exploiting resources;
Importance of new instruments in observing and studying the ocean; and
Changing political status of the ocean.

EARLY USE OF THE SEA

The sea played an important role in human affairs long before human history was written down. Shells in refuse piles of ancient coastal villages show that seafood was important in the villagers' diets. Some refuse piles also contain bones of deep-sea animals, which suggests that boats may have been used in fishing well offshore, even though we have no direct evidence of such seafaring capabilities.

Transportation by sea must also have been an important activity in early human history, but little evidence remains of these ancient maritime activities. Wood, skins, reed—materials commonly used in primitive boats—are rarely preserved. The earliest evidence comes

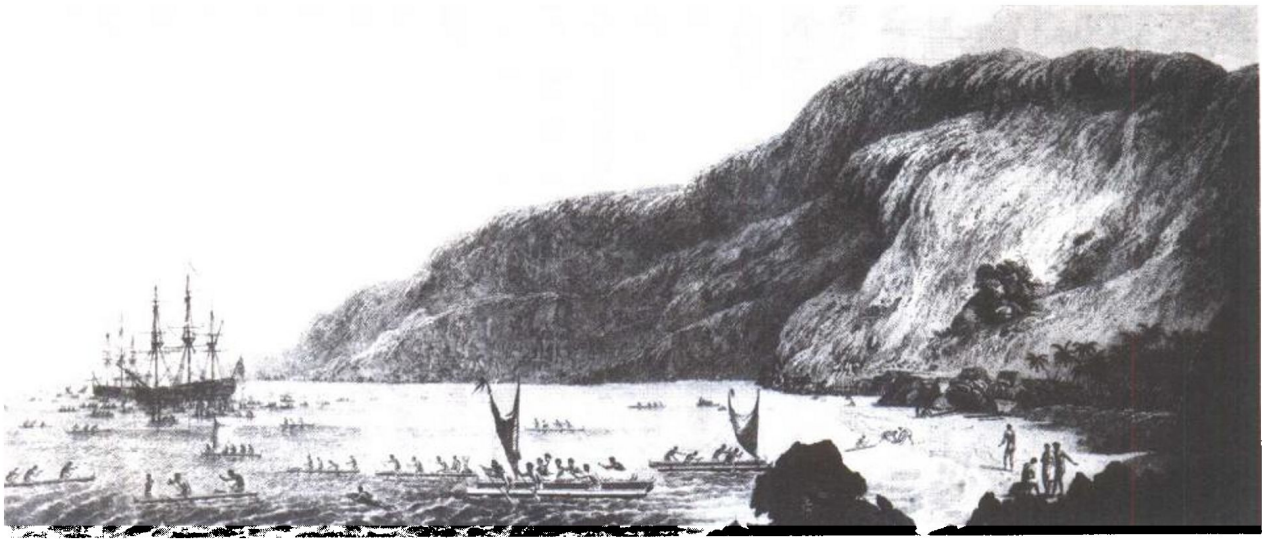


FIGURE 1-4
Large sailing canoes (center) were used by Polynesians for their trans-Pacific voyages. They were still being used when Europeans first arrived. (Courtesy Bishop Museum.)

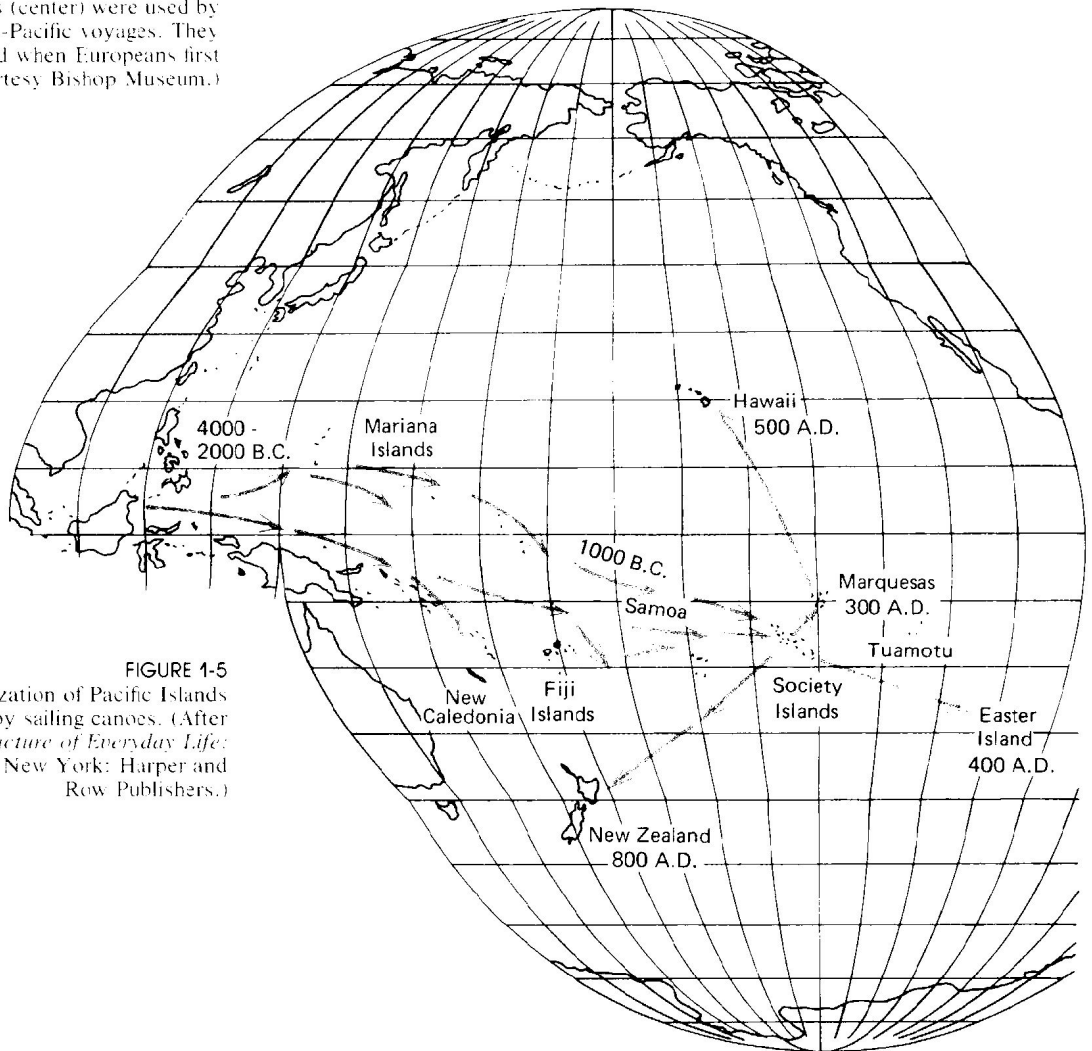


FIGURE 1-5
Polynesian colonization of Pacific Islands required long voyages by sailing canoes. (After F. Braudel, 1981, *The Structure of Everyday Life: Limits of the Possible*. New York: Harper and Row Publishers.)

from rock carvings in Norway that show boats similar to those later used by the Vikings. The earliest models and ships known come from Egyptian tombs and Viking graves. All suggest that these peoples were highly skilled sailors.

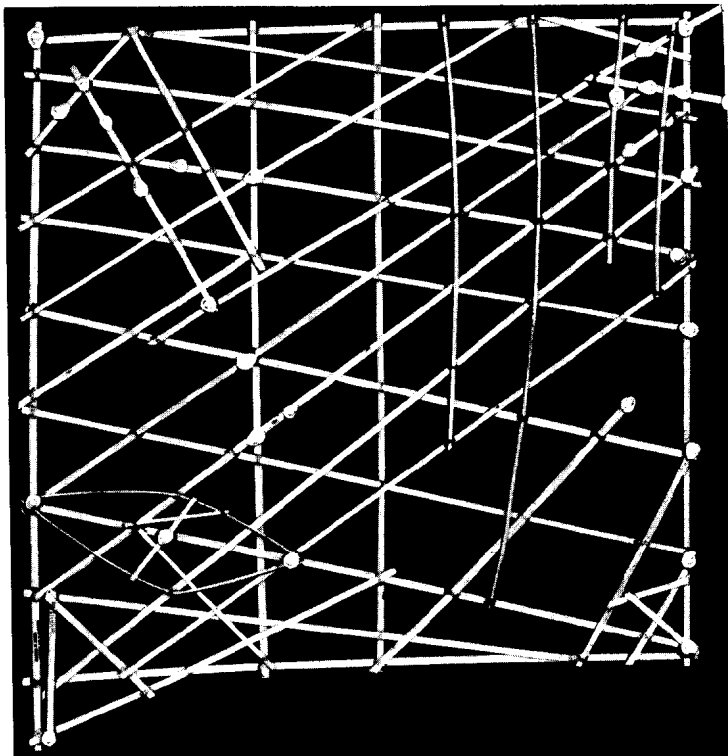
Four kinds of boats appear in rock carvings or are mentioned in ancient texts: dugouts made from logs that were hollowed and shaped by fire and simple tools, reed boats constructed of bundles of reeds lashed together, boats made of split sections of thin bark sewn together and stretched over a wooden frame (the birch bark canoe of American Indians), and skin boats made of sewn animal hides stretched over a wood frame. Boats similar to these were used extensively within recorded history. Some have been reconstructed from drawings and descriptions. Successful open-ocean voyages made in them show that they were quite capable of extensive voyages.

Early human migrations also argue for extensive seafaring. Around 10,000 years ago, western Europe was colonized by peoples from Africa who must have crossed the Strait of Gibraltar, which at that time was never less than 10 kilometers (6 miles) wide. Seaborne commerce was also developed early in human history. Around 1000 B.C. the *Phoenicians* had an extensive navy and dominated trade in the Mediterranean and adjacent waters in the North Atlantic. They sailed as far as England to get tin for making bronze.

Polynesians constructed elaborate double-hulled vessels (Fig. 1-4). The largest of these had living quarters for people and animals. They were used in transoceanic voyages to colonize the islands of the Pacific, including Hawaii (Fig. 1-5). The *Micronesians* colonized many of the larger islands of the western Pacific.

We know little about the seafaring traditions of these peoples, as there are no written records. In many cases our information comes from the accounts of the first European explorers to contact them. There is ample evidence, however, that they were skillful sailors and experienced navigators. One example of their navigational skills is the stick charts (Fig. 1-6) used by the *Micronesians*. Shells mark locations of islands, and the bamboo strips show wave patterns. Stars, cloud patterns, and winds were also used to navigate between islands.

FIGURE 1-6
Micronesian navigators used stick charts to sail the Pacific. Islands are represented by shells. Prevailing wave directions are shown by bamboo strips. Effects of islands on wave patterns are shown by the curved bamboo strips around the islands in the lower left. (Photograph courtesy Library of Congress.)



CHINESE OCEAN EXPLORATION

Between 1405 and 1433, early in the Ming dynasty (1368–1644), the Chinese undertook seven voyages in the Pacific and Indian oceans. These were the largest peacetime voyages ever undertaken, involving 37,000 men and 317 ships.

The Chinese ships were far bigger than any in western Europe. The largest had nine masts, was 135 meters (444 feet) long, and had a beam (width) of 55 meters (180 feet). They employed modern features, such as transverse bulkheads, which divided the ships into several watertight compartments. Thus if a ship's hull were slightly damaged, the water could be confined to one compartment. (Such construction is now standard in ships.) Magnetic compasses and detailed navigation charts were also used.

These expeditions were unlike any before or since. They did not seek to conquer, to collect treasure, to make religious converts, or to gather scientific information. Instead, they were to extend Chinese influence. The Chinese tradition can best be summarized as "live and let live." China was then far more advanced technologically than the rest of the world and was essentially self-sufficient for food and raw materials. In their eyes, the Chinese had nothing useful to learn or to gain from the outside world. Thus these expeditions were undertaken simply to display the splendor and power of the Ming dynasty.

Under the Chinese system, tributary states brought gifts to acknowledge China as the most civilized country in the world. To demonstrate their superior position, the Chinese felt obligated to give back more than they received. Tributary states were thus a financial drain. Expanding their influence simply increased the financial burden on the country. The expeditions brought back animals unknown to the Chinese, such as giraffes, to add to the imperial zoo. Otherwise these voyages contributed little to China.

Bowing to internal politics and economic pressures, the emperor ended these voyages, and China turned to internal developments. For example, the 2500-kilometer-long (1500 miles) *Great Wall* was strengthened to repel the Tartars and Mongols on China's northwest frontier. The 1600-kilometer-long (1000 miles) *Grand Canal* was also repaired and rebuilt so that boats could use it all year. This ended the need for the coastwise sailing to transport goods and grain around the country. By the early 1500s, when western Europe was beginning to expand its horizons through ocean exploration, the Chinese government was outlawing seafaring, withdrawing inward, and beginning a period of isolation that lasted until the mid-nineteenth century. The great Chinese expeditions made no lasting contribution to improving our understanding of the ocean.

ANCIENT OCEAN EXPLORATION

Many ocean features and processes were well known in Europe in antiquity. Some knowledge came from the stories of explorers and seafarers. But little was written down, perhaps because the knowledge was so valuable. Consequently, we know little of the extent of their knowledge.

Much of what we do know comes from the writings of philosophers and theologians, based on their analyses of the observations and reports of seafarers and explorers. *Aristotle* (384–322 B.C.), for instance, noted that the sea neither dries up nor overflows. He con-

cluded, therefore, that the amount of rainfall must equal evaporation over the earth. *The Venerable Bede* (673–735), English historian and theologian, knew that the moon controls the tides. Tables of predictions of the tides at London Bridge were issued in the late twelfth or early thirteenth century.

European use of magnetic compasses was first recorded in the thirteenth century. The oldest surviving chart for ship navigation dates from A.D. 1275. It provides compass directions and indicates distances.

Various other devices were used for navigating at sea. For example, to determine distance a sandglass was used in conjunction with a log attached to a line to determine speed through the water. The log was thrown overboard and the line allowed to run out until all the sand had run through the glass. Another device used to determine water depth and position was the *lead line*. A weight with sticky wax on the bottom was attached to a line and thrown overboard. The amount of line fed out before the weight touched the bottom indicated water depths. The type of material recovered on the wax could be compared with notations on a chart to obtain some idea of location. Navigation charts still show areas of sand, mud, and shells on the bottom.

EUROPEAN OCEAN EXPLORATION

Publication in 1410 of a Latin edition of *Ptolemy's* (ca. A.D. 140) map greatly influenced thinking in western Europe. His maps were immensely influential. His influence was so great that it took centuries before all the mistakes in Ptolemy's maps were finally removed from newly made maps. Ptolemy's maps were simply copied uncritically until finally replaced by the results of new exploration.

The great age of European ocean exploration began early in the fifteenth century. It was probably stimulated by the knowledge gained from the rediscovery of Greek and Arab geography in the Islamic libraries when southern Spain was recaptured by Christian armies. Along with Ptolemy's maps came two ideas well known to the Greeks: (1) The earth was a sphere, and (2) the ocean was navigable. These ideas came to Europe from studies of the manuscripts in the Islamic libraries.

Portugal led in the early European exploration of the Atlantic. The Canary Islands off northwest Africa were explored in 1416. The Azores, in the middle of the Atlantic, were discovered by Europeans between 1427 and 1432. Perhaps the most influential individual was Portugal's *Prince Henry the Navigator* (1392–1460), who established a center for seafaring in southern Portugal. There he bought the most learned people to teach navigation to Portuguese sea captains. His efforts greatly stimulated Portuguese exploration.

In the voyages that followed, the west coast of Africa was explored. Portuguese navigators reached the tip of South Africa (near present-day Cape Town) in 1488. *Vasco da Gama* (1460–1524) reached India in May 1498. His discovery opened up profitable trade routes from Portugal and India.

Development of the three-masted ship (Fig. 1-7) was a major reason for the success of western European exploration of the sea. The ships were large enough to carry men and supplies for long trading and exploring voyages. New sail designs were sturdy enough to contend with the stormy North Atlantic. Previously most seafaring had been limited to the Mediterranean. There the longest voyages were only a