INTRODUCTION TO OCEAN SCIENCES pdf

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Introduction to Ocean Sciences uses students' natural enthusiasm for the wonders of the ocean as a foundation for teaching core principles in this interdisciplinary field. Developing scientific literacy by emphasizing the real-world process of science, this text provides an accessible introduction to the interrelated physical, chemical.

Developing scientific literacy by emphasizing the real-world process of science, this text provides an accessible introduction to the interrelated physical, chemical, biological, and geological processes of the oceans, atmosphere, and coasts. The Second Edition has been fully revised and updated and offers improved pedagogy, an expanded art program featuring beautiful underwater photography by the author, and new multimedia resources for students and instructors. Contents Engages students with the issues that matter to them. A strong focus on the ecological perspective sets the Second Edition apart from other textbooks in the field. Accurate and current science in a flexible, modular format. Providing the most current and accurate science of any introductory text in the field, Introduction to Ocean Sciences is organized in a modular format, with thoroughly cross-referenced chapters, allowing instructors to re-order or otherwise tailor the textbook material to fit the needs of their course. Introduction to Ocean Sciences makes the study of ocean sciences accessible. Emphasizing the scientific process, the text explains in clear language the essential scientific concepts from the various ocean science disciplinesâ€”physics, chemistry, geology, biology, and ecologyâ€”while providing the opportunity for more in-depth study through eighteen illustrated Critical Concept features. Rich pedagogy clarifies and reinforces essential concepts. Because courses in the ocean sciences attract nonmajors, Introduction to Ocean Sciences provides the pedagogy to ensure that even those with little science experience will succeed. Throughout every chapter, Critical Thinking Questions challenge students to apply the concepts they have learned. Students who are less comfortable with the science will get the support they need to dip their toes into new materials, and added depth is provided for those who want to know more. Individual Critical Concepts are referenced in the chapters themselves: Accurate line art and beautiful underwater photography. The Second Edition offers almost underwater photographs by author Douglas Segar and Elaine Stamman Segar, who have meticulously supervised their reproduction for color accuracy. The text also includes a wealth of exceptional full-color line art to illustrate important concepts. History and Challenges of Ocean Studies 3. Studying the Oceans This chapter provides fundamental explanations of the many methods by which ocean science data is gathered. Collecting it here gives students an overall appreciation of the interdisciplinary nature of ocean science before they dive into the discipline-oriented chapters. Critical Concepts This section includes 18 illustrated page-featuresâ€”see the complete list of topics below. Uniquely designed to allow students to apply these concepts even if they find the more detailed technical explanations challenging. Evolution of the Ocean Floor Introduces ocean and land topographical features by describing how plate tectonics and other processes lead to their formation. History and Evidence Explores the evidence supporting the plate tectonics theoryâ€”which is treated as a prime example of the scientific method at work. Water and Seawater 7. Physical Properties of Water and Seawater 8.

2: Douglas A. Segar (Author of Introduction to Ocean Sciences)

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Early history[edit] Humans first acquired knowledge of the waves and currents of the seas and oceans in pre-historic times. Observations on tides were recorded by Aristotle and Strabo. Early exploration of the oceans was primarily for cartography and mainly limited to its surfaces and of the animals that fishermen brought up in nets, though depth soundings by lead line were taken. Franklin and Timothy Folger printed the first map of the Gulf Stream in â€" James Rennell wrote the first scientific textbooks on oceanography, detailing the current flows of the Atlantic and Indian oceans. During a voyage around the Cape of Good Hope in , he mapped "the banks and currents at the Lagullas ". In â€" Edward Forbes undertook dredging in the Aegean Sea that founded marine ecology. The first superintendent of the United States Naval Observatory â€" , Matthew Fontaine Maury devoted his time to the study of marine meteorology, navigation , and charting prevailing winds and currents. His textbook Physical Geography of the Sea was one of the first comprehensive oceanography studies. Many nations sent oceanographic observations to Maury at the Naval Observatory, where he and his colleagues evaluated the information and distributed the results worldwide. Almost nothing was known of the ocean depths. As exploration ignited both popular and scientific interest in the polar regions and Africa, so too did the mysteries of the unexplored oceans. The seminal event in the founding of the modern science of oceanography was the â€" Challenger expedition. As the first true oceanographic cruise, this expedition laid the groundwork for an entire academic and research discipline. Challenger , leased from the Royal Navy, was modified for scientific work and equipped with separate laboratories for natural history and chemistry. Challenger during the years â€" Murray, who supervised the publication, described the report as "the greatest advance in the knowledge of our planet since the celebrated discoveries of the fifteenth and sixteenth centuries". He went on to found the academic discipline of oceanography at the University of Edinburgh , which remained the centre for oceanographic research well into the 20th century. In the late 19th century, other Western nations also sent out scientific expeditions as did private individuals and institutions. The first purpose built oceanographic ship, Albatros, was built in In , Fridtjof Nansen allowed his ship, Fram, to be frozen in the Arctic ice. This enabled him to obtain oceanographic, meteorological and astronomical data at a stationary spot over an extended period. The first acoustic measurement of sea depth was made in Between and the "Meteor" expedition gathered 70, ocean depth measurements using an echo sounder, surveying the Mid-Atlantic ridge. Sverdrup, Johnson and Fleming published The Oceans in , [12] which was a major landmark. The Sea in three volumes, covering physical oceanography, seawater and geology edited by M. The theory of seafloor spreading was developed in by Harry Hammond Hess. The Ocean Drilling Program started in The United States nuclear submarine Nautilus made the first journey under the ice to the North Pole in From the s, there has been much emphasis on the application of large scale computers to oceanography to allow numerical predictions of ocean conditions and as a part of overall environmental change prediction. Geosat seafloor mapping data became available in Study of the oceans is linked to understanding global climate changes, potential global warming and related biosphere concerns. The atmosphere and ocean are linked because of evaporation and precipitation as well as thermal flux and solar insolation. Wind stress is a major driver of ocean currents while the ocean is a sink for atmospheric carbon dioxide. Oceanographic frontal systems on the Southern Hemisphere The study of oceanography is divided into these four branches: Biological oceanography, or marine biology , investigates the ecology of marine organisms in the context of the physical, chemical and geological characteristics of their ocean environment and the biology of individual marine organisms. Chemical oceanography and ocean chemistry , are the study of the chemistry of the ocean. Whereas chemical oceanography is primarily occupied with the study and understanding of seawater properties and its changes, ocean chemistry focuses primarily on the geochemical cycles. Geological oceanography, or marine geology , is the study of the geology of the ocean floor including plate tectonics and paleoceanography.

3: Introduction to Ocean Sciences, 2e

Introduction to Ocean Sciences has 15 ratings and 0 reviews. The text provides students with a basic understanding of the scientific questions, complexit.

History and Challenges of Ocean Studies Guide to Reading and Learning Many of you reading this chapter will have had little or no personal experience with the oceans except perhaps for a visit or two to the coast. Also, many will have had little exposure to the history of human use, exploration, and study of this area that covers two thirds of our planet. There is good reason for this. The oceans are an environment that is not part of our natural habitat. It is a changeable, sometimes dangerous environment for humans, and throughout history the vast expanses of the oceans have been used somewhat uneasily by humans seeking mainly food and safe passage from one coast to another. Recreational uses, except for the esthetic pleasures of watching the oceans from land, are a very recent development in human history. Thus, exploration and study of the oceans has lagged many centuries behind human explorations and scientific studies of the land and terrestrial ecosystems. In this chapter we start by reviewing the history of ocean exploration and the use of the oceans as a means of transportation for colonization and trade. Perhaps you will be surprised that this was almost all of the study that humans did on the oceans until a little more than years ago. Perhaps you will be surprised that ocean scientists can precisely date the first systematic scientific studies of the oceans to the year Did you know that a group of men lived and worked from December until May on a sailing vessel that was only about three-quarters of a football field long and only a few meters wide? Their small vessel, the Challenger, was crammed from stem to stern with scientific sampling and measurement equipment. They sailed more than , km around the world at a top speed of no faster than a bicyclist can sustain, performing the first systematic studies of the oceans. They did so in an age before practical electricity and the electric light was invented. After the Challenger expedition, study of the oceans developed at an ever more furious pace. In this chapter, we have the opportunity to review the highlights of the many discoveries and technological developments that have led to the sophisticated methods that we now use to study the oceans. Yet even today those studies are performed in an environment that is in many ways much more difficult for scientists to study than the surface of the moon or Mars. At the end of this chapter we examine the reasons why the oceans are so difficult to study. As you read this material, think about how much more difficult it must have been for the early oceanographers, who not only had to contend with these difficulties but who did so without the scientific instruments, modes of communication, and personal comforts that we now have from electricity. Oceanography has only recently developed from mapping the oceans to a much more comprehensive suite of ocean sciences. Physical, chemical, geological, and biological processes in the oceans are all intimately linked and interdependent. As a result, oceans sciences must be interdisciplinary. Prehistory Evidence indicates that marine fishes were caught and eaten by early humans about more than 40, years ago. Evidence exists that boats, fishhooks, and nets were used 8, year ago and probably earlier. Primitive boats were probably made of animal skins, tree bark reeds, and woodâ€”all of which decompose relatively quicklyâ€”so, although no direct archaeological evidence has been found, boats have probably existed for many tens, perhaps hundreds, of thousands of years. The Mediterranean Centered on the island of Crete about bce, the Minoans are considered the first recorded civilization to use boats extensively for transport, trade, defense, and conquest. Seafaring continued to develop in ancient Greek and Egyptian civilizations, but the Phoenicians, who lived in parts of what are now Israel, Lebanon, and Syria between about bceand bce, were the next great sea power. The earliest crude maps of coastlines were made several thousand years ago. The earliest known detailed and generally accurate map was a rendering of the Mediterranean drawn by the Greek Herodotus in bce. Ptolemy, another Greek, who lived around ce, was the most famous early mapmaker. His maps were the basis for all maps until the s. These errors in eastâ€”west distances were only corrected in the s when chronometers that could work at sea were developed. The Greeks made many other observations about the Earth and oceans. Micronesia and Polynesia About 4, years ago the large islands of the far west Pacific Ocean and Micronesia were colonized, and from there about 1, years later the Polynesians, colonized the western and central Pacific islands. The Polynesians also later colonized the Pacific as far south as New Zealand, as far north as Hawaii, and as far east as Easter Island. Polynesians used double-hulled catamarans, a design still in use due to its stability in high seas. They navigated using knowledge of the stars, winds, wave patterns, clouds, and seabirds that was unwritten but passed down by generations of navigators. However, in the mid s a new wave of European exploration and systematic mapping of the oceans began. Captain James Cook voyages between and are considered the first systematic exploration, study, and mapping of the oceans. The Birth of Oceanography By the early s several nations had agencies dedicated to mapping the oceans to facilitate safe navigation and trade. The Beagle In â€", Charles Darwin sailed as the naturalist aboard the Beagle on a hydrographic survey of the tip of South America. On this voyage he developed his famous theory of evolution, but also observed marine fossils high in the Andes Mountains. He concluded that this discovery meant that the continents were not fixed and unchanging as geologists then believed. Darwin also proposed a theory of formation of coral atolls that reflects our current understanding of the process. The Challenger The first expedition mounted purely to study the oceans themselves, rather than to map them, was the voyage of the Challenger in â€" Challenger sailed around the world and collected observations of water temperature, both at the surface and at depth; current velocities; meteorological data; soundings of ocean depths to more than m; samples of seafloor sediments; samples of fishes and other organisms; and visual observations of birds and mammals. Because systematic ocean studies began with the Challenger in they have been underway for only a little more than a century. The Modern Era Since the Challenger expedition there has been intensive study of the oceans supported by many technological advances and resulting in many sometimes-surprising discoveries Major advances in technologies that have benefited ocean sciences include scuba and submersibles, remotely operated and autonomous instrument packages, satellites, and computers. Major revelations of ocean science studies include the first detailed seafloor map of the world in , the discovery of hot brines at the bottom of the Red Sea in , the discovery of chemosynthetic communities at hydrothermal vents in , the growing understanding of plate tectonics and the many observations that led to the acceptance of the plate tectonic theory, and the major revelations of ocean complexity that came to light when the first satellites made synoptic measurements of ocean processes possible. Almost none of the remote sensing tools used to study the surface of the Earth, moon, and planets can see beyond a few meters into the ocean waters. Radio, radar, light, and all other electromagnetic radiation is absorbed by water. Only gravity, sound, and magnetic fields pass easily through ocean waters. Inaccessibility The oceans are deepâ€"an average of 3. Lowering instruments to the seafloor and retrieving them can take many hours. Ships that carry researchers to study the oceans travel only slowly and are costly to build and operate. Navigation at sea was difficult until the relatively recent development of satellite-based GPS navigation systems, and GPS does not work underwater. Pressure Pressure increases very rapidly with depthâ€"approximately 1 additional atmosphere of pressure for every 10 m of depth. While spacecraft experience a 1 atmosphere pressure change, instrument packages and submersibles must endure an increase of more than atmospheres of pressure to reach the deep-sea floor. Conductivity, Corrosion, and Fouling Ocean water is electrically conductive and corrosive. As a result all electronic equipment used in the oceans must be contained in sealed waterproof housings unlike instrument in unmanned satellites, which can be safely exposed to space , and corrosion and fouling by organisms such as barnacles makes it very difficult to deploy instruments in the oceans for any extended period of time. Wave Motion The ocean surface is dynamic. This means that seasickness and fatigue a problem for many ocean scientists and makes it difficult and dangerous to handle equipment needed to deploy and retrieve instruments and samplers. The constant vibration and pounding experienced on a research ship in rough weather renders some scientific instruments completely unusable, and almost all instruments and computers need to be specially modified or designed specifically to operate reliably in this environment. Logistics The logistics of working far from land on a research vessel are difficult. If instruments or equipment fail, they must be repaired on site with available parts and by the personnel on board. Equipment cannot be taken to a repair shop and spare parts cannot be obtained if they are not already carried on the research vessel. Many oceanographic and climate models are extremely complex and require the use of the fastest supercomputers. To read CC10 go to page 26CC.

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4: Introduction to Ocean Sciences | W. W. Norton & Company

The dawn of ocean sciences. HMS Challenger is made fast to St. Paul's Rocks on the Mid-Atlantic Ridgeâ€”a hazardous taskâ€”during the first part of its expedition.

Ocean Sediments Guide to Reading and Learning Sediments accumulate in layers on the seafloor and, in doing so, preserve a historical record of climate change and other events such as volcanic eruptions and meteor impacts. We begin Chapter 8 by describing the large range of sizes and compositions of the many different types of particle that can be found in marine sediments. Then we visit each of the four major types of material that make up these particles and learn how they are transported to, and deposited in, the oceans. Most of you will be familiar with the concept that rivers carry particles of eroded rock and soil to the oceans. However, did you know that most eroded rock particles that are found in sediments of the deep oceans are not transported by rivers but instead through the atmosphere by winds? Did you know that the remains of living marine organisms can not only be found in ocean sediments but, in fact, in many locations comprise most of the particles in the sediments? Or, did you know that some rocks on land are composed almost entirely of the remains of a single type of marine organism that was deposited in the oceans long ago, compacted, and then uplifted by tectonic processes to form the rock formations where they are found? The species that comprise most of the particles in ocean sediments are microscopically small plankton. In this chapter we provide a brief introduction to the various types of plankton that are so abundant in the oceans that they can accumulate in layers tens of meters or more thick in seafloor sediments. Pay attention to these organisms for, as we find in later chapters, they form the foundations of life in the oceans. Although these sources are smaller than eroded rock and biological remains, they are disproportionately more important in other ways. For example, did you know that metal-rich sediments, whose existence was unknown until the late twentieth century, are now found to lie in numerous locations along the oceanic ridges and elsewhere, and that these sediments could provide an economically viable commercial source of certain rare metals? Did you know that these metal-rich sediments are deposited around hydrothermal vents that were discovered only in , and that these vents support entire ecosystems of numerous species that depend on chemosynthesis, or that these vent ecosystems were completely unknown until â€"a discovery that was as unexpected as finding life on Mars would be? Most meteorites burn up in the atmosphere to form small particles of dust. Ocean sediments contain a record of this and other impacts that can be read using the information that this chapter includes on the origin, characteristics, and transport routes of ocean sediment particles. However, they may be classified by their general characteristics. Classification by Grain Size Sediments may be classified by grain size Sediment particles range from boulders to grains so small that they cannot be distinguished except under the most powerful microscopes. However, most sediments deposited at a specific location and time consist primarily of grains that are within a narrow range of particle sizes and are said to be well sorted. Sediments are generally classified as gravel, sand, or mud which can be subdivided into silt and clay in descending order of their predominant grain size. Classification by Origin Sediments may be classified by the origin of the majority of their particles. Sediment particles may be derived from land lithogenous , biological processes biogenous , chemical precipitation from sweater hydrogenous , or derived from meteorites cosmogenous. The distribution of sediment particles from these different origins within ocean sediments at different locations is determined by many factors including grain size, location of origin, susceptibility to decomposition or dissolution in seawater, and the mechanisms of particle transport. During weathering, easily dissolved minerals are removed, leaving mostly siliceous minerals including quartz, feldspars, and clay minerals. Clay minerals are layered structures of silicon, aluminum, and oxygen atoms, some containing iron and other elements. They are carried to the oceans by rivers, glaciers, and winds, or eroded from coastlines by waves. Transport by Rivers Most rivers slow down as they near the ocean, and many flow slowly over flat coastal plains so that larger particles are generally deposited in river valleys and only small particles are carried out to the oceans. However, during storm runoff events large amounts of larger particles can be resuspended from the river bed and carried to the ocean, where they accumulate in sediments near the river mouth. Rivers that flow across active subduction zone margins are generally short due to the coastal mountain ranges and carry relatively small quantities of suspended sediment because they drain only small area of land. The largest amounts are carried by four rivers: In the area where these rivers discharge to the oceans extensive deep sediment deposits extend to the deep sea floor in the form of abyssal fans. Most of the other rivers that transport large quantities of suspended sediments to the oceans empty into marginal seas. Erosion by Glaciers Glaciers erode very large amount of rock from their valleys, producing particles ranging from large boulders to extremely fine particles. Many high-latitude glaciers empty directly into the oceans or end near where the glacial valley meets the sea. Icebergs that break off glaciers can carry their eroded rock long distances into the oceans to be released as the iceberg melts Glaciers release their eroded rock at their lower ends. Much of this material then washes out to the ocean, especially the very fine-grained material called glacial flour because it remains suspended for long periods and can give the water a milky appearance in lakes or fjords where the glacier empties. Erosion by Waves Waves continuously erode coastlines. Sediment particles released to the oceans by coastal wave erosion are similar to riverborne suspended sediments but often have a larger proportion of unweathered mineral grains. Wave erosion creates particles of all sizes. Wave action then sorts the particles, transporting small ones offshore and leaving larger ones on or close to the shore. Transport by Winds Dust particles can be carried very long distances through the atmosphere. For example, Sahara Desert sand grain dust is transported across the Atlantic Ocean, where it can be easily identified on air filters placed at the coastline in Florida. Dust particles in the atmosphere are eventually deposited on the ocean surface and sink slowly to the seafloor. Fine wind-blown dust particles fall over all parts of the oceans at a relatively uniform rate. Although this rate is slow, atmospheric dust accumulate continuously and is a major component of sediments that are remote from land and have very slow accumulation rates of other types of particles. Explosive volcanic eruptions of subduction zone volcanoes can inject very large quantities of fragmented rock into the atmosphere. Historical records suggest that large eruptions such as the one that created Long Valley caldera in California can inject hundreds of cubic kilometers of pulverized rock into the atmosphere. The largest particles injected into the atmosphere by volcanic eruptions rain out near the eruption site, but smaller particles can stay in the atmosphere for years and are distributed around the world before they eventually rain out onto the land or ocean. Transport by Landslides Landslides on coastlines can carry lithogenous materials of a wide range of particle sizes into the oceans, where they are incorporated in the sediments. Slumps and turbidity currents on the continental slopes can carry lithogenous sediments from the continental shelf into trenches or out over the abyssal plain where there is no trench. Most phytoplankton are consumed by larger organisms called zooplankton that excrete organic-rich fecal material. This material is often in the form of fecal pellets, which are larger than the individual phytoplankton that compose them and sink much faster. Marine species larger than zooplankton also produce fecal pellets. Much of the organic matter in fecal pellets is decomposed by bacteria and other organisms or consumed by detritus feeders as it sinks through the water column or after it has been deposited on the seafloor. As a result, most ocean sediments contain little organic matter. Biogenous particles are predominantly the solution-resistant silica or calcium carbonate hard parts of microscopic phytoplankton and zooplankton. The two major factors affecting the accumulation rate of biogenous particles in sediments are the rate of production of the particles in the overlying water column and the rate of decomposition or dissolution of the particles. Biogenous particles can dominate sediments in areas where the productivity is high in the overlying water, but not where the hard parts are dissolved before they can accumulate in the sediments. Regional Variations of Biogenous Particle Production In high latitudes diatoms are the dominant photosynthetic organisms. They have siliceous hard parts and they dominate the inputs of biogenous material to the sediments. At lower latitudes, many of the dominant photosynthetic organisms have no hard parts so inputs of biogenous material to sediments are limited except in certain regions where coccolithophores grow in abundance. Some zooplankton, small free-floating animals that eat phytoplankton, also have hard parts that can contribute to, or dominate, sediments in some areas. Foraminifera and pteropods have calcareous hard parts, whereas radiolaria have silica hard parts. Radiolaria are abundant in those tropical waters that have high productivity and can dominate sediments in these areas. Dissolution of Biogenous Particles Calcium carbonate particles dissolve more easily at higher pressures depths , whereas silica particles dissolve very slowly at all depths and their dissolution rate actually decreases with increasing depth. Thin siliceous hard parts may be dissolved before they reach the seafloor but not thicker hard parts. For example, hard parts from diatoms will accumulate in the sediments whatever the depth if they are abundant in the overlying water. The upper layers of seawater are generally saturated or supersaturated with calcium carbonate, so calcareous material does not dissolve. However, calcium carbonate solubility increases with increasing pressure depth and decreasing temperature. Because deep water in the oceans is cold, the calcium carbonate dissolution rate increases substantially with increasing depth. There are two types of calcium carbonate hard parts: Some types of animal have calcite hard parts e. Aragonite dissolves more easily than calcite so pteropod hard parts are totally dissolved at shallower depths than foraminifera hard parts. Where pteropods are more abundant than foraminifera, sediments at shallow depths may consist primarily of pteropod remains, in deeper water the pteropods are dissolved and sediments may be dominated by foraminifera remains, and at even deeper depths both forms of calcium carbonate are totally dissolved and the sediments contain no calcium carbonate. Carbonate Compensation Depth The depth below which all calcium hard parts are dissolved before they can accumulate in sediments is called the carbonate compensation depth, or CCD. No calcium carbonateâ€”containing particles survive to be accumulated in surface sediments below the CCD. The CCD varies between oceans and historically over time. Deep waters of the oceans are formed by sinking of cold surface water in certain regions near the poles. The cold water is saturated with carbon dioxide but as pressure increases the saturation solubility increases and deep water dissolves additional carbon dioxide released by respiration and decomposition of organic matter as the water flows through the ocean basins. The CCD is affected not only by changes in temperature and pressure but also by changes in dissolved carbon dioxide concentration. Adding dissolved carbon dioxide to water lowers the pH and increases the solubility of calcium carbonate. As a result, the CCD is shallower in those area of the oceans where the deep water is older a longer period of time since it left the surface. The CCD is shallower in the Pacific Ocean than in the Atlantic Ocean and is shallower in the South Atlantic Ocean than in the North Atlantic Ocean, reflecting the formation of deep water in an area near Greenland and the flow of this water southward to the south polar region and then around Antarctica and north into the Pacific Ocean. No deep water is formed in the North Pacific Ocean. Carbonate Compensation Depth and the Greenhouse Effect Changes in the mean CCD over time can have a major effect on the distribution of carbon dioxide between the atmosphere, oceans, and ocean sediments and so are important for greenhouse effect studies. The higher concentration of carbon dioxide in surface ocean waters that has resulted from human use of fossil fuels will eventually reach the deep waters and may increase pH sufficiently to significantly reduce the CCD. This would cause more calcium carbonate to dissolve and the excess carbon dioxide could be released to the atmosphere when the water returns to the surface, providing a positive feedback to the enhanced greenhouse effect. Hydrothermal Minerals Heat flowing up through thin mantle, especially at the oceanic ridges, drives hydrothermal vents that discharge hot water. The mechanism involved is not known but is thought to be convection of water heated within the rocks and sediments and replacement of this water by percolation of seawater into the rocks and sediments from areas surrounding the vents. Hydrothermal vents have been found on the oceanic ridges in many locations throughout the oceans and are probably quite common. The vents support communities of unique organisms that depend on chemosynthetic primary production by microbial organisms in the vent water as the ultimate source of their food.. The temperature and composition of the water discharged by hydrothermal vents varies. However, most vent plumes have no oxygen, substantial sulfide concentrations, and high concentrations of iron, manganese, and other metals including copper, cobalt, lead, nickel, silver, zinc that have soluble sulfides. Once discharged into the surrounding ocean water, metal sulfides are oxidized and precipitate as a rain of fine particles of their hydrous oxides. Some particles sink to the seafloor to form metal-rich sediments in areas surrounding the vents and others are transported and deposited far from the vent to contribute to sediments elsewhere. Test-mining of metal-rich hydrothermal sediments has occurred in the Red Sea, where restricted circulation has allowed large concentrations of such sediments to accumulate. Undersea Volcano Emissions Hydrothermal vents have recently been found to exist on the flanks of hot-spot and magmatic-arc volcanoes where, in some instances, they discharge their fluids at much shallower depths even sometimes within the photic zone than at the oceanic ridges. Manganese Nodules Manganese nodules are dark brown, rounded lumps of rock, often larger than a potato, that are found lying on the abyssal ocean floor in high abundance in some locations. Manganese nodules form by precipitation of minerals from seawater and are usually formed initially around a large sediment particle such as a shark tooth. The minerals build in concentric layers around the nodule in a manner similar to tree rings, and occasional disturbance by marine organisms is thought to be necessary for the nodules to grow on all sides and in order that they not be buried by new sediments.

INTRODUCTION TO OCEAN SCIENCES pdf

5: Introduction to Ocean Sciences by Douglas A. Segar

Chapter 2: History and Challenges of Ocean Studies Guide to Reading and Learning. Many of you reading this chapter will have had little or no personal experience with the oceans except perhaps for a visit or two to the coast.

The Ocean Planet Guide to Reading and Learning Most of us have watched videos of the underwater world that lies beneath the ocean surface and some of us have even been lucky enough to visit a small portion of that world. The strange looking world of the seafloor and the amazing abundance and variety of ocean life are most likely one of the things that have drawn you to study the oceans. However, did you know that life as we know, even terrestrial life, could not exist on our planet Earth without the oceans? Did you know that the oceans and ocean resources are essential to modern civilization in many ways that far exceed the value of the fisheries that they sustain? This book explores these and many other aspects of the oceans that intersect our lives and, by the time you finish reading, you will understand why we call Earth the Ocean Planet. This first chapter of our journey through the oceans presents a brief overview of the many ways that the ocean is important to human civilization and our everyday lives. One connection with our lives is highlighted here and will be revisited many times throughout the text: Simply stated, global climate change induced by the greenhouse effect is probably the most important challenge ever faced by human civilization. The key to understanding climate change, and its likely effects on us, is to understand the intimate dance of interactions between the oceans and atmosphere. There were not always oceans on Earth and there are no oceans on any of the other planets or moons in our solar system. You will learn briefly what we know about the history of the formation of the Earth and its oceans. This will reveal to you just how unusual, although probably not unique in the universe, our ocean planet is. It will also show you just how critical the oceans are to the development of life. To describe our Earth and its oceans scientists often use many perhaps unfamiliar scientific units and types of graphical presentation, and this text is no exception. Thus we end this chapter with an explanation of how you should study and interpret information presented in a map, graph or chart, and how you can interpret the scientific notation and units that we use. We must learn the basic elements of this language of science before we can communicate with each other about Earth and ocean sciences. Learning the basics of this language will ensure that you can understand, more easily learn and, most importantly, enjoy the concepts and information in the book. Graphics are used extensively in the text to visually represent what is usually communicated by way of mathematical formulae. A wealth of information is contained in these graphics and you should carefully study each figure in detail. Many texts use graphics as illustration, but here you will find that the graphics are an integral part of the learning experience. Chapter 1 Essential to Know Critical Concepts used in this chapter 1. Human interactions with the oceans have changed the oceans in many ways. The enhanced greenhouse effect is driven by releases of carbon dioxide methane and other gases into the atmosphere. The excess carbon dioxide and other greenhouse gases do not block the suns energy, but do block the longer wavelength energy emitted by the Earth to space. In this way the balance between energy input and energy output to the Earth is altered. The problem of global climate change is, therefore, one of the most important driving forces behind much of contemporary ocean research. Stars do not last foreverâ€”they are created and eventually die. At that point it collapses and then expand again to become a red giant. Its temperature then becomes high enough to burn helium and form carbon and other moderately heavy elements, causing it to collapse again and blow off its outer layer into space, becoming a white dwarf. A large star burns until all of its hydrogen has been converted to carbon and other moderately heavy elements, causing it to expand and become a red supergiant. It then shrinks and becomes much hotter, fusing even the moderately heavy elements until they are converted almost entirely to iron. All elements heavier than iron were originally formed in such supernovae. Formation of the Solar System The sun was formed about 5 billion years ago and, since the solar system contains elements heavier than iron, some of the material that came together to form the solar system must have originated in supernovae. As the planets formed, solar wind blew the lighter elements, especially hydrogen and helium, out from the region of the inner planets. As a result the composition of the planets varies with distance from the sun. The closest planet to the sun, Mercury, is mostly iron. Venus, Earth and

Mars have less iron but more moderately heavy elements such as silicon and oxygen. The outer planets, Jupiter, Saturn, Uranus and Neptune, are composed mostly of light elements, primarily in the form of ammonia and methane. As Earth cooled water vapor in the atmosphere condensed and fell as rain but quickly evaporated again. This continued for about 25 million years until Earth had cooled sufficiently so that water could accumulate to form the oceans. The Earth has oceans and life, while Mars and Venus do not. Venus is much hotter than the Earth because it has a much higher carbon dioxide concentration in its atmosphere. Therefore, it has a much stronger greenhouse effect. However, it is believed the first organisms may have been chemosynthetic microbes similar to those found at hydrothermal vents and other extreme environments where free oxygen is deficient or unavailable. Life has existed on Earth for about 3. Photosynthetic organisms were responsible for altering the chemistry of the atmosphere, which contained little oxygen until about 2 billion years ago. It took about 1 billion years for the atmosphere to reach its current oxygen concentration. The oceans and atmosphere have been in a relative steady state since this time, about 1 billion years ago. Invertebrates, the first higher animal life, developed in the oceans about million years ago. Fishes appeared about million years ago and the first land plants about 70 million years later. Mammals did not develop until about million years ago and hominids only appeared about 4 million years ago. These graphs can be misleading unless you carefully examine the axes. Contour Plots and Profiles Spatial distributions of variables are often displayed in two dimensional contour plots. The width of spaces between contours in a contour plot provides an indication of the gradient of the plotted parameter. However, this can be misleading unless you carefully examine the data intervals between the contours. Often, data is contoured and the areas between contours are depicted by colors that represent a range of values. The convention most often used is that higher values of the contoured parameter are in red, while progressively lower values follow the order of the spectrum of visible light: Vertical distributions are usually represented by profiles which are vertical slices through the Earth or ocean. Most vertical profiles are vertically exaggerated. Latitude is easily measured, while longitude is expressed in reference to an arbitrary north-south line and can only be measured accurately if an accurate chronometer is available. Different projections are used for different reasons, but no projection preserves all four desirable characteristics: Scientific Notation and Units Scientific notation, in which numbers are expressed as powers of ten, is used to simplify the use of very large or very small numbers which are frequently encountered in Earth sciences. A system of Scientific Units or SI units has been developed to standardize the way things are measured. The system is based on seven basic units. All other units are derived from these. Many of the SI units are not yet in universal use but their use is steadily increasing. It also makes it possible for these changes to occur in rapid, unpredictable jumps between one set of conditions and a second, completely different set of conditions.

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