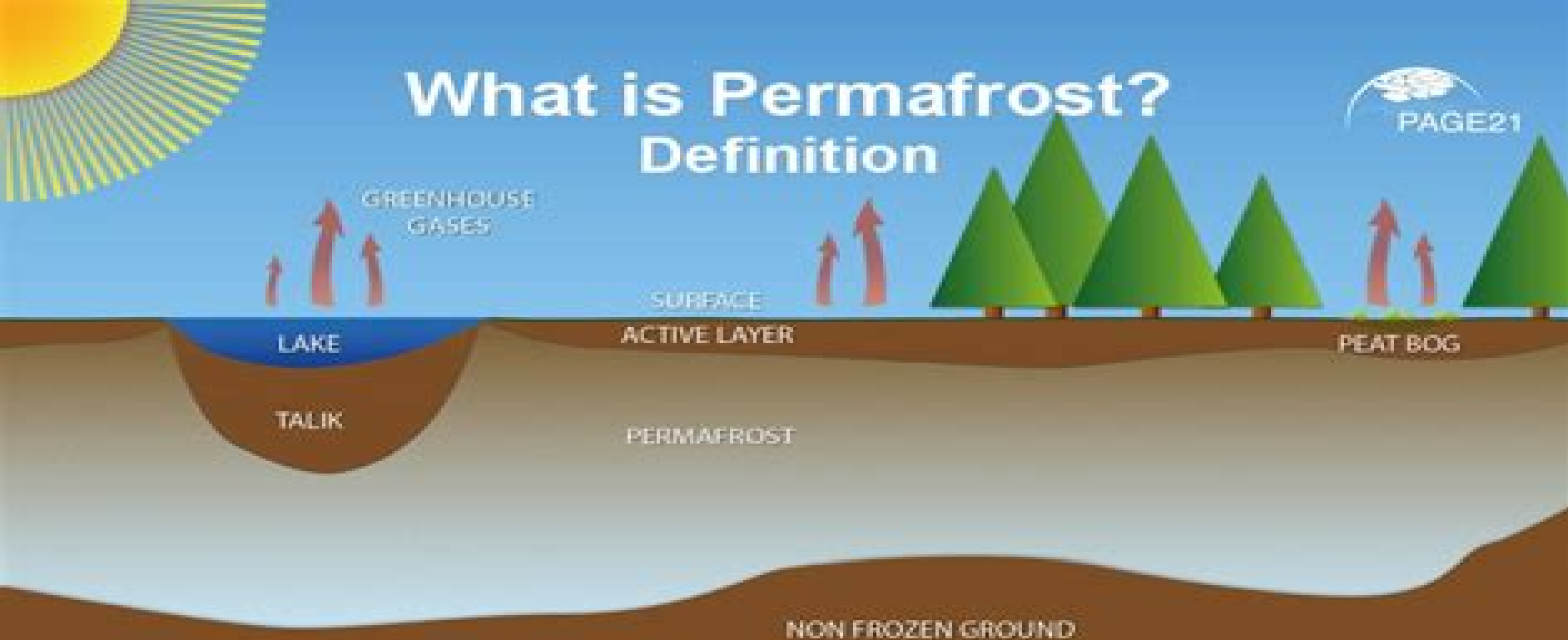


# What is Permafrost?

## Definition



Permafrost is defined as ground, soil or rock, including ice or organic material, that remains at or below 0°C for at least two consecutive years.

The regions in which permafrost occurs occupy approximately 24% (23 million km<sup>2</sup>) of the northern hemisphere.

Permafrost is formed when the ground cools down in winter and produces a frozen layer below the surface that then remains frozen throughout the following summer, or longer.

# The Permafrost Environment

**E Durkheim**



## **The Permafrost Environment:**

**The Permafrost Environment** Stuart A. Harris, 2021-09-28 Originally published in 1986 The Permafrost Environment examines how the search for oil gas and minerals in the arctic region instigated new and vitally important needs to understand the permafrost environment The construction of roads airfields buildings and pipelines in this inhospitable environment has posed enormous problems for engineers and geologists This book is a comprehensive review of the nature of the permafrost environment and its utilization It looks at environmental processes and their effects and examines the management problems which result It provides a detailed look at how normal procedures for construction etc need to be modified to cope with the special conditions and it gives examples from throughout the arctic region including Canada Siberia Alaska Greenland and Northern Scandinavia *Permafrost Environment Changes in a Warming Climate* Xiaodong Wu, Cuicui Mu, Wenxin Zhang, 2022-11-30 Thawing Permafrost J. van Huissteden, 2020-01-01 This book provides a cross disciplinary overview of permafrost and the carbon cycle by providing an introduction into the geographical distribution of permafrost with a focus on the distribution of permafrost and its soil carbon reservoirs The chapters explain the basic physical properties and processes of permafrost soils ice mineral and organic components and how these interact with climate vegetation and geomorphological processes In particular the book covers the role of the large quantities of ice in many permafrost soils which are crucial to understanding carbon cycle processes An explanation is given on how permafrost becomes loaded with ice and carbon Gas hydrates are also introduced Structures and processes formed by the intense freeze thaw action in the active layer are considered e g ice wedging cryoturbation and the processes that occur as the permafrost thaws pond and lake formation erosion The book introduces soil carbon accumulation and decomposition mechanisms and how these are modified in a permafrost environment A separate chapter deals with deep permafrost carbon gas reservoirs and recently discovered methane emission phenomena from regions such as Northwest Siberia and the Siberian yedoma permafrost The Periglacial Environment Hugh M. French, 2017-10-27 The Periglacial Environment Fourth Edition is an authoritative overview of the world's cold non glacial environments First published in 1976 and subsequently revised in 1996 and 2007 the text has been the international standard for nearly 40 years The Fourth Edition continues to be a personal interpretation of the frost induced conditions geomorphic processes and landforms that characterize periglacial environments Part One discusses the periglacial concept and describes the typical climates and ecosystems that are involved Part Two describes the geocryology permafrost science associated with frozen ground Part Three outlines the weathering and geomorphic processes associated with cold climate conditions Part Four provides insight into the periglacial environments of the Quaternary especially the Late Pleistocene Part Five describes some of the problems associated with human occupancy in regions that experience frozen ground and cold climate conditions Extensively revised and updated Written by an expert with over 50 years of field research Draws upon the author's personal experience from Northern

Canada Alaska Siberia Tibet Antarctica Svalbard Scandinavia southern South America Western Europe and eastern North America This book is an invaluable reference for advanced undergraduates in geography geology earth sciences and environmental sciences programs and to resource managers and geotechnical engineers interested in cold regions

Sensitivity of permafrost to climate warming in Canada , **Permafrost Soils** Rosa Margesin,2008-10-31 Most of the Earth's biosphere is characterized by low temperatures Vast areas 20% of the soil ecosystem are permanently frozen or are unfrozen for only a few weeks in summer Permafrost regions occur at high latitudes and also at high elevations a significant part of the global permafrost area is represented by mountains Permafrost soils are of global interest since a significant increase in temperature is predicted for polar regions Global warming will have a great impact on these soils especially in northern regions since they contain large amounts of organic carbon and act as carbon sinks and a temperature increase will result in a release of carbon into the atmosphere Additionally the intensified release of the climate relevant tracer gas methane represents a potential environmental hazard Significant numbers of viable microorganisms including bacteria archaea phototrophic cyanobacteria and green algae fungi and protozoa are present in permafrost and the characteristics of these microorganisms reflect the unique and extreme conditions of the permafrost environment Remarkably these microorganisms have been reported to be metabolically active at subzero temperatures even down to 20 °C **Encyclopedia of**

**Geomorphology** Andrew Goudie,2013-04-15 Geomorphology the discipline which analyzes the history and nature of the Earth's surface deals with the landforms produced by erosion weathering deposition transport and tectonic processes In recent decades there have been major developments in the discipline and these are reflected in this major Encyclopedia the first such reference work in the field to be published for thirty five years Encyclopedia of Geomorphology has been produced in association with the International Association of Geomorphologists IAG and has a truly global perspective The entries have been written by an international editorial team of contributors drawn from over thirty countries who are all among the leading experts in the discipline In two lavishly illustrated volumes Encyclopedia contains nearly 700 alphabetically organized entries to provide a comprehensive guide both to specific landforms and to the major types of geomorphological processes that create them The Encyclopedia also demonstrates the major developments that have taken place in recent years in our knowledge of tectonic and climatic changes and in the use of new techniques such as modelling remote sensing and process measurement Older concepts however are not forgotten and provide an historical perspective on the development of ideas Both accessible and authoritative Encyclopedia of Geomorphology is destined to become the definitive resource for students researchers and applied practitioners in the field of geomorphology and the cognate disciplines of geography earth science sedimentology and environmental science **Acid Mine Drainage, Rock Drainage, and Acid**

**Sulfate Soils** James A. Jacobs,Jay H. Lehr,Stephen M. Testa,2014-04-10 Provides the tools needed to analyze and solve acid drainage problems Featuring contributions from leading experts in science and engineering this book explores the complex

biogeochemistry of acid mine drainage rock drainage and acid sulfate soils It describes how to predict prevent and remediate the environmental impact of acid drainage and the oxidation of sulfides offering the latest sampling and analytical methods Moreover readers will discover new approaches for recovering valuable resources from acid mine drainage including bioleaching Acid Mine Drainage Rock Drainage and Acid Sulfate Soils reviews the most current findings in the field offering new insights into the underlying causes as well as new tools to minimize the harm of acid drainage Part I Causes of Acid Mine Drainage Rock Drainage and Sulfate Soils focuses on the biogeochemistry of acid drainage in different environments Part II Assessment of Acid Mine Drainage Rock Drainage and Sulfate Soils covers stream characterization aquatic and biological sampling evaluation of aquatic resources and some unusual aspects of sulfide oxidation Part III Prediction and Prevention of Acid Drainage discusses acid base accounting kinetic testing block modeling petrology and mineralogy studies It also explains relevant policy and regulations Part IV Remediation of Acid Drainage Rock Drainage and Sulfate Soils examines both passive and active cleanup methods to remediate acid drainage Case studies from a variety of geologic settings highlight various approaches to analyzing and solving acid drainage problems Replete with helpful appendices and an extensive list of web resources Acid Mine Drainage Rock Drainage and Acid Sulfate Soils is recommended for mining engineers and scientists regulatory officials environmental scientists land developers and students *Microbiology of Extreme Soils* Patrice Dion, Chandra Shekhar Nautiyal, 2007-12-22 My auxiliaries are the dews and rains which water this dry soil and what fertility is in the soil itself which for the most part is lean and effete Henry David Thoreau Walden Pond The concerns that Thoreau had about his beans were nothing to those that would face a similarly conscientious gardener in the Atacama Desert or on the planet Mars where dews are rare or frozen and rains are extremely rare or absent altogether Yet we live in a time when an appreciation of the differences and similarities among soils or regolith no organics detected on Mars as yet can provide a perspective on life at its most fundamental level that of microbiology Microbes are the Earth's finest chemists and most prodigious chemical engineers Beyond pure chemistry they know tricks with electrons that would make any Silicon Valley chip designer blush with pride And yet their size and association with human food good and diseases bad has for more than a century obscured their essential place in making the Earth a habitable planet for humans One of the most interesting facets of this book is that we are shown those chemists at work in one of their most important habitats Soils comprise both a pervasive environment on our planet and one of the most important even most fruitful of habitats with respect to human survival *Arctic Research of the United States*, 1992 *Climate Change* Trevor Letcher, 2021-02-26 Climate Change Observed Impacts on Planet Earth Third Edition brings together top global researchers across many disciplines to provide a comprehensive review on the complex issue of climate change and weather patterns The third edition continues its tradition of focusing on the science and evidence on this highly politicized topic Every chapter is updated with this new edition featuring new chapters on topics such as glacier melt the impacts of rising temperatures extreme weather

modeling techniques biodiversity and more This book is essential for researchers environmental managers engineers and those whose work is impacted by or tied to climate change and global warming Provides a comprehensive resource on climate change and weather patterns ranging from causes and indicators to modeling and adaptation Covers the Jet Stream catastrophic modeling extreme weather the carbon cycle socioeconomic impacts biological diversity deforestation and global temperature Contains 25 updated chapters and 10 new chapters all written by global experts who provide a current overview of the state of knowledge on climate change across a wide array of disciplines Climate and Anthropogenic Impacts on Earth Surface Processes in the Anthropocene Achim Beylich, Daniel Vázquez Tarrío, Dongfeng Li, Marc Oliva, Mario Morellón Marteles, 2024-10-03 Climate and Anthropogenic Impacts on Earth Surface Processes in the Anthropocene outlines our current understanding of the effects of ongoing and accelerated environmental changes on Earth surface processes and details the systematic and quantitative methodology on the actual drivers of these processes This book covers various geomorphological process domains and a wide range of terrestrial surface environments on Earth It provides a broad spectrum of advanced techniques and methods of data collection and generation together with various approaches and methods of data analysis and geomorphologic modelling This book is a valuable resource for upper level undergraduates graduates and academics studying Earth surface processes as well as researchers and professionals in needing a comprehensive overview of Earth surface process change and influence during the Anthropocene Comprehensively covers climatic and anthropogenic drivers of earth surface processes including detection and quantification techniques Includes the latest research and suggestions for adapted and sustainable mitigation and management strategies Includes worked examples and case studies of anthropogenic and climate influences on Earth surface processes **Microbial Life in the Cryosphere and Its Feedback on Global Change** Susanne Liebner, Lars Ganzert, 2021-01-18 The cryosphere stands for environments where water appears in a frozen form It includes permafrost glaciers ice sheets and sea ice and is currently more affected by Global Change than most other regions of the Earth In the cryosphere limited water availability and subzero temperatures cause extreme conditions for all kind of life which microorganisms can cope with extremely well The cryosphere s microbiota displays an unexpectedly large genetic potential and taxonomic as well as functional diversity which however we still only begin to map Also microbial communities influence reaction patterns of the cryosphere towards Global Change Altered patterns of seasonal temperature fluctuations and precipitation are expected in the Arctic and will affect the microbial turnover of soil organic matter SOM Activation of nutrients by thawing and increased active layer thickness as well as erosion renders nutrient stocks accessible to microbial activities Also glacier melt and retreat stimulate microbial life in turn influencing albedo and surface temperatures In this context the functional resilience of microbial communities in the cryosphere is of major interest Particularly important is the ability of microorganisms and microbial communities to respond to changes in their surroundings by intracellular regulation and population shifts within functional niches respectively

Research on microbial life exposed to permanent freeze or seasonal freeze thaw cycles has led to astonishing findings about microbial versatility adaptation and diversity Microorganisms thrive in cold habitats and new sequencing techniques have produced large amounts of genomic metagenomic and metatranscriptomic data that allow insights into the fascinating microbial ecology and physiology at low and subzero temperatures Moreover some of the frozen ecosystems such as permafrost constitute major global carbon and nitrogen storages but can also act as sources of the greenhouse gases methane and nitrous oxide In this book we summarize state of the art knowledge on whether environmental changes are met by a flexible microbial community retaining its function or if the altered conditions also render the community in a state of altered properties that affect the Earth s element cycles and climate This book brings together research on the cryosphere s microbiota including permafrost glaciers and sea ice in Arctic and Antarctic regions Different spatial scales and levels of complexity are considered spanning from ecosystem level to pure culture studies of model microbes in the laboratory It aims to attract a wide range of parties with interest in the effect of climate change and or low temperatures on microbial nutrient cycling and physiology

*The Arctic* Jack D. Ives, Roger G. Barry, 2019-09-18 Originally published in 2000 The Arctic provides a comprehensive overview of the region s rapidly changing physical and human dimensions and demonstrates the importance of communication between natural scientists social scientists and local stakeholders in response to the tremendous challenges and opportunities facing the Arctic It is an essential resource for all Arctic researchers particularly those developing multidisciplinary projects It provides an overview of key areas of Arctic research by renowned specialists in the field and each chapter forms a detailed varied and accessible account of current knowledge Each author introduces the subject to a specialist readership while retaining intellectual integrity and relevance for specialists Overall the richness of the material presented in this volume reflects the ecological and cultural diversity of this vast and environmentally critical part of the globe

**Proceedings of the ... International Soil Correlation Meeting (ISCOM).** ,1989 Proceedings of the Sixth International Soil Correlation Meeting (VI ISCOM) ,1991 *Borehole Climatology* Louise Bodri, Vladimir Cermak, 2011-08-29 Climate for the 21st century is expected to be considerably different from the present and recent past Industrialization growth combined with the increasing CO2 concentration in the atmosphere and massive deforestation are well above the values over the past several decades and are expected to further grow Air temperature is rising rapidly well as does the weather variability producing frequent extreme events Six of the ten warmest years occurred in the 1990s Temperatures predicted for the 21st century ranges well above the present day value The time period of the last 100 200 years covered by the direct meteorological observations is too short and does not provide material to reliably assess what may happen over the next hundred s years A faithful prediction of the future requires understanding how climate system works i e to reconstruct past climate much further in the past Borehole paleoclimatology enables climate reconstruction of the past several millennia unlike proxy methods provides direct past temperature assessment and can well broaden the areal

range to the remote regions poorly covered with meteorological observations Considerable debates have recently focused on the causes of the present day warming i e to distinguish between the natural and anthropogenic contribution to the observed temperature increase eventually to quantify their regional distribution Complex interpretation of borehole data with the proxies and additional socio economic information can hopefully help On observed data taken in various places all over the world we demonstrate suitable examples of the interaction between the subsurface temperature response to time changes in vegetation cover land use farming and urbanization Precise temperature time monitoring in shallow subsurface can further provide the magnitude of the present day warming within relatively short time intervals As far as we know there exists so far no book dealing entirely with the subject of the Borehole climatology Only relatively rarely this method is mentioned in otherwise plentiful literature on climate reconstruction or on climate modelling There are however series of papers focussing on various borehole climate related studies in numerous journals e g Global and Planetary Change Climate Change Tectonophysics Journal of Geophysical Research Geophysical Research Letters etc Time to time a special issue appears to summarize papers on this topic presented during specialized symposia Key Features Description of a new useful alternative paleoclimate reconstruction method A suitable source of information for those wishing to learn more about climate change Material for lecturing and use in the classroom Ample practical examples of borehole temperature inversions worldwide Ample illustrations and reference list Authors have a good knowledge of the problem based on more than 20 years of experience one of them actually pioneered the method Description of a new useful alternative paleoclimate reconstruction method A suitable source of information for those wishing to learn more about climate change Material for lecturing and use in the classroom Ample practical examples of borehole temperature inversions worldwide Ample illustrations and reference list Authors have a good knowledge of the problem based on more than 20 years of experience one of them actually pioneered the method

**Permafrost Response on Economic Development, Environmental Security and Natural**

**Resources** R. Paepe, 2001-04-30 Proceedings of the NATO Advanced Research Workshop Novosibirsk Russia 12 16

November 1998 **Encyclopedia of Snow, Ice and Glaciers** Vijay P. Singh, Pratap Singh, Umesh K. Haritashya, 2011-06-29

The earth's cryosphere which includes snow glaciers ice caps ice sheets ice shelves sea ice river and lake ice and permafrost contains about 75% of the earth's fresh water It exists at almost all latitudes from the tropics to the poles and plays a vital role in controlling the global climate system It also provides direct visible evidence of the effect of climate change and therefore requires proper understanding of its complex dynamics This encyclopedia mainly focuses on the various aspects of snow ice and glaciers but also covers other cryospheric branches and provides up to date information and basic concepts on relevant topics It includes alphabetically arranged and professionally written comprehensive and authoritative academic articles by well known international experts in individual fields The encyclopedia contains a broad spectrum of topics ranging from the atmospheric processes responsible for snow formation transformation of snow to ice and changes in their properties



classification of ice and glaciers and their worldwide distribution glaciation and ice ages glacier dynamics glacier surface and subsurface characteristics geomorphic processes and landscape formation hydrology and sedimentary systems permafrost degradation hazards caused by cryospheric changes and trends of glacier retreat on the global scale along with the impact of climate change This book can serve as a source of reference at the undergraduate and graduate level and help to better understand snow ice and glaciers It will also be an indispensable tool containing specialized literature for geologists geographers climatologists hydrologists and water resources engineers as well as for those who are engaged in the practice of agricultural and civil engineering earth sciences environmental sciences and engineering ecosystem management and other relevant subjects

*Source-to-Sink Fluxes in Undisturbed Cold Environments* Achim A. Beylich, John C. Dixon, Zbigniew Zwoliński, 2016-07-07 Amplified climate change and ecological sensitivity of polar and cold climate environments are key global environment issues Understanding how projected climate change will alter surface environments in these regions is only possible when present day source to sink fluxes can be quantified The book provides the first global synthesis and integrated analysis of environmental drivers and quantitative rates of solute and sedimentary fluxes in cold environments and the likely impact of projected climate change The focus on largely undisturbed cold environments allows ongoing climate change effects to be detected and moreover distinguished from anthropogenic impacts A novel approach for co ordinated and integrative process geomorphic research is introduced to enable better comparison between studies This highly topical and multidisciplinary book which includes case studies covering Arctic Antarctic and alpine environments will be of interest to graduate students and researchers in the fields of geomorphology sedimentology and global environmental change

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## **Table of Contents The Permafrost Environment**

1. Understanding the eBook The Permafrost Environment
  - The Rise of Digital Reading The Permafrost Environment
  - Advantages of eBooks Over Traditional Books
2. Identifying The Permafrost Environment
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an The Permafrost Environment
  - User-Friendly Interface
4. Exploring eBook Recommendations from The Permafrost Environment
  - Personalized Recommendations
  - The Permafrost Environment User Reviews and Ratings
  - The Permafrost Environment and Bestseller Lists
5. Accessing The Permafrost Environment Free and Paid eBooks
  - The Permafrost Environment Public Domain eBooks

- The Permafrost Environment eBook Subscription Services
- The Permafrost Environment Budget-Friendly Options
- 6. Navigating The Permafrost Environment eBook Formats
  - ePub, PDF, MOBI, and More
  - The Permafrost Environment Compatibility with Devices
  - The Permafrost Environment Enhanced eBook Features
- 7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of The Permafrost Environment
  - Highlighting and Note-Taking The Permafrost Environment
  - Interactive Elements The Permafrost Environment
- 8. Staying Engaged with The Permafrost Environment
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers The Permafrost Environment
- 9. Balancing eBooks and Physical Books The Permafrost Environment
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection The Permafrost Environment
- 10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
- 11. Cultivating a Reading Routine The Permafrost Environment
  - Setting Reading Goals The Permafrost Environment
  - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of The Permafrost Environment
  - Fact-Checking eBook Content of The Permafrost Environment
  - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks

## 14. Embracing eBook Trends

- Integration of Multimedia Elements
- Interactive and Gamified eBooks

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