AREA 5

THE HISTORY OF THE EARTH

AREA TIME EMPHASIS	TOPIC		TIME
30 DAYS	XIII	Interpreting Geologic History	15 days
	XIV	Landscape Development and Environmental Change	15 days

How Can Geologic History Be Interpreted?

Time Emphasis: 15 days

TOPIC ABSTRACT

Major Behavioral Objectives

At the completion of this topic, the student should be able to:

A. Collect and analyze evidence of several geologic events in a field situation, and establish a chronological order.
B. Establish a correlation between different locations using rock and fossil evidence.
C. Determine the relative and/or absolute ages of rocks or geologic events from data such as fossil evidence, radioactive decay evidence, erosion, and deposition.
D. Draw inferences concerning ancient life from a study of the fossil record.

Approach

This topic explores some of the techniques that geologists use to interpret the geologic history recorded in the rocks. Most of the processes considered in topics IX, X, XI, and XII play an important role in the interpretation and should be reconsidered where appropriate.

The analysis, synthesis, and interpretation of geologic events is a form of puzzle solving, and the student can play the role of chief investigator or puzzle solver. Once some of the techniques are learned, he can enjoy working out a geologic history for a specific area.

Investigation of local geological features is strongly suggested during this topic. The use of specific field experiences can help make the interpretation of geologic history more realistic to the student. Seeing at firsthand is far superior to reading and talking about things in far-away places. Where field trips are impossible, slides, samples, and maps of the local geology can be substituted for the actual field trip experience.

The focus of this topic should be upon the process of making interpretations rather than upon the actual record. Particular events from the geologic past of New York State and other areas should be used as illustrations of interpretations that have been made.

In considering the geologic record, students should be left with the impression that the interpretations constitute probable events rather than indisputable facts.

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TOPIC OUTLINE	MAJOR UNDERSTANDINGS	INFORMATION TO TEACHERS
A. Geologic events		
A-1 Sequence of geologic events	**A-1 How can the order in which geologic events occurred be determined?**	**XIII-A-1**
A-1.1 Chronology of layers	A-1.11 The bottom layer of a series of sedimentary layers is the oldest, unless the series has been overturned or has had older rock thrust over it.	PIO-5; CCO-8, 12

TOPIC OUTLINE	MAJOR UNDERSTANDINGS	INFORMATION TO TEACHERS
A-1.2 Igneous intrusions and extrusions	A-1.21 Rock layers are older than igneous intrusions which cut through them or igneous extrusions which are above them.	PIO-5; CCO-8, 12
A-1.3 Faults, joints, and folds	A-1.31 Rocks are older than faults, joints, or folds that appear in them.	PIO-5; CCO-8, 12
A-1.4 Internal characteristics	A-1.41 Fragments which occur within a rock are older than the rock.	PIO-5; CCO-5, 8, 12
	A-1.42 Cracks, veins, and mineral cement are younger than the rocks in which they occur.	PIO-5; CCO-8, 12
B. Correlation techniques		
B-1 Correlation	**B-1** *How can rocks and geologic events in one place be matched to another?*	**XIII-B-1**
B-1.1 Continuity	B-1.11 Rock layers can often be traced from one location to another directly by "walking the outcrop."	CCO-10, 12
B-1.2 Similarity of rock	B-1.21 Rocks can often be tentatively matched on the basis of similarity in appearance, color, and composition.	B-1.21 It is important in this section to carefully distinguish *evidence* from *inference*. PIO-5; CCO-6, 8, 10, 12
B-1.3 Fossil evidence	B-1.31 Fossils are found almost exclusively in sedimentary rocks.	CCO-6, 7, 8
	B-1.32 Fossils provide clues to the environments in which the organisms lived.	CCO-6, 7, 8, 12
	B-1.33 Fossils which occurred widely but only within a particular formation can be used to correlate sedimentary rocks.	PIO-5; CCO-6, 8, 10, 12
B-1.4 Volcanic time markers	B-1.41 Because of their rapid deposition over a large area, layers of volcanic ash occurring between other layers may serve as time markers.	PIO-5; CCO-6, 7, 9, 10, 12
B-1.5 Anomalies to correlation	B-1.51 Careful study may show that two similar rock formations may be of different ages. A single formation may actually be older in some places than in others.	B-1.5 The interpretation of geologic history can be *oversimplified*, leading to misconception. Cautious interpretation can minimize this problem.

TOPIC OUTLINE	MAJOR UNDERSTANDINGS	INFORMATION TO TEACHERS
C. Determining geologic ages		
C-1 Rock record	***C-1 What does the rock record suggest about geologic history?*** **XIII-C-1**	
C-1.1 Fossil evidence	C-1.11 Events in geologic history can often be placed in order according to relative age by using evidence provided by certain fossils.	PIO-3, 5; CCO-8, 12
C-1.2 Scale of geologic time	C-1.21 Geologists have subdivided geologic time into units, based on fossil evidence.	C-1.21 For further subdivisions see the geologic time scale in the Reference Tables. PIO-5
	C-1.22 Most of the geologic past is devoid of a fossil record.	PIO-5; CCO-6, 8, 10
	C-1.23 Man's existence is infinitesimal in comparison with geologic time.	C-1.23 A major intent in this section is to help the student develop a model through which he can gain some comprehension of the scale of geologic time. PIO-1, 3
C-1.3 Erosional record	C-1.31 Buried erosion surfaces indicate gaps in the time record. The gaps represent periods of destruction of the geologic record.	PIO-5; CCO-7, 8, 12
C-1.4 Geologic history of an area	C-1.41 The geologic history of an area can be inferred from the evidence of former influence by a variety of processes.	C-1.41 The geologic map of New York State and the geologic time scale that appear in the reference tables may be used to illustrate the various portions of the rock record that have been preserved in New York State. PIO-1, 2, 3, 5; CCO-5, 6, 7, 8, 9, 10, 11, 12
C-2 Radioactive decay	***C-2 How can geologic ages be measured by using radioactive decay?*** **XIII-C-2**	
C-2.1 Decay rates		C-2.1 Models are used extensively to implement this section. Students should be cautioned to interpret the models with care so that misapplication of the concept is avoided.
	C-2.11 Some rocks contain atoms whose nuclei undergo radioactive decay.	PIO-3, 4, 5; CCO-1, 2, 4, 7, 11
	C-2.12 The disintegration of an individual atom occurs as a random event.	PIO-3, 5; CCO-7, 10, 11, 12

TOPIC OUTLINE	MAJOR UNDERSTANDINGS	INFORMATION TO TEACHERS
	C-2.13 The disintegration of a radioactive substance occurs at a predictable rate.	CCO-7, 11, 12
	C-2.14 The disintegration rate is unaffected by external factors.	CCO-6
C-2.2 Half-lives	C-2.21 The half-lives are different for different radioactive substances.	CCO-7, 12
	C-2.22 Radioactive substances with short half-lives, such as C^{14}, are good for dating recent organic remains. Those with longer half-lives, such as U^{238}, are useful for dating older remains.	
C-2.3 Decay product ratios	C-2.31 The age of a rock can often be inferred from the relative amounts of the undecayed substance and the decay product.	PIO-1, 3, 4; CCO-2, 6, 7, 11, 12
D. The fossil record		
D-1 Ancient life	**D-1** ***What does the fossil record suggest about ancient life?*** **XIII-D-1**	
D-1.1 Variety of life forms	D-1.11 Fossils give evidence that a great many kinds of animals and plants have lived on earth in the past under a great variety of environmental conditions and that most of them have become extinct.	CCO-6, 8, 9, 12
	D-1.12 In addition to the fossil types which have been found, it is highly probable that an even greater number have left no traces in the rocks.	CCO-6, 8, 9, 12
D-1.2 Evolutionary development	D-1.21 Variations within a species can be observed, measured, and described.	PIO-1, 2, 4, 5
	D-1.22 It has been theorized that the variations within a species may provide some members with a higher probability of survival.	PIO-5; CCO-6, 8, 9, 12
	D-1.23 The similarity among some fossil forms of various time periods suggests a transition which may be a result of evolutionary development.	PIO-1, 2, 4, 5; CCO-6, 11

What Causes Landscapes?

Time Emphasis: 15 days

TOPIC ABSTRACT

Major Behavioral Objectives

At the completion of this topic, the student should be able to:
A. Identify and measure various local landscape characteristics.
B. Develop inferences from observations of various landscapes, local and remote, about the influence of the environment on landscape development.

Approach

Environmental analysis should be stressed in this topic. The concept of landscapes as indicators of the interaction of crustal forces, climate, and man should be carefully developed and extensively explored. Students should become *actively* involved in the interpretation of landscapes and environmental changes from firsthand field experiences.

The use of a specific field experience with field trips to appropriate locations is very desirable. Slides, maps, or photographs may be used to provide secondhand experiences in situations where the firsthand experience is not possible or needs supplementation.

The interdisciplinary nature of man's influence in producing environmental change may suggest a coordinated approach by the social studies and science departments.

The student should complete this topic, and the course, with a questioning attitude and some plausible ideas about the formation of *any* landscape and the influence of various factors on *his* environment.

The material in this topic may be related to several other topics as indicated in the Information to Teachers column.

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TOPIC OUTLINE	MAJOR UNDERSTANDINGS	INFORMATION TO TEACHERS
A. Landscape characteristics		
A-1 Quantitative observations	**A-1** *What are some landscape characteristics that can be observed and measured?*	**XIV-A-1**
A-1.1 Hillslopes	A-1.11 Hillslopes with distinctive shapes can be identified and measured.	PIO-1, 2, 5; CCO-11
A-1.2 Stream patterns	A-1.21 Stream patterns which have measurable characteristics can be identified.	A-1.21 Relate to topic IX. PIO-1, 2, 5; CCO-11
A-1.3 Soil associations	A-1.31 Various soil associations can be identified and some of their characteristics can be measured.	A-1.31 Relate to topic IX. PIO-1, 2, 5; CCO-11

TOPIC OUTLINE	MAJOR UNDERSTANDINGS		INFORMATION TO TEACHERS
A-2 Relationship of characteristics	**A-2** *How are landscape characteristics related?*		**XIV-A-2**
A-2.1 Landscape regions	A-2.11 Sets of landscape characteristics seem to occur together, identifying distinctive landscape regions.		PIO-5; CCO-11, 12
	A-2.12 The boundaries between landscape regions are usually well defined.		PIO-5; CCO-12
	A-2.13 Any continental land mass has several distinctive types of landscape regions which can be identified.		PIO-5; CCO-12
	A-2.14 The surface of New York State has several distinctive landscape regions.		PIO-5; CCO-12
B. Landscape development			
B-1 Environmental factors	**B-1** *How is landscape development influenced by environmental factors?*		**XIV-B-1**
B-1.1 Uplifting and leveling forces	B-1.11 Landscapes seem to result from the interaction of uplifting and leveling forces.	B-1.11	Relate to topic IX and topic XIII. PIO-3, 5; CCO-1, 4, 5, 6, 7, 8, 10, 11, 12
	B-1.12 In a particular landscape, one of the forces, uplifting or leveling, may be dominant.		PIO-3, 5
	B-1.13 The rate of crustal uplift or subsidence may result in a modification of landscape by altering hillslopes, drainage patterns, or orographic wind patterns.	B-1.13	Relate to topic VIII and XII. PIO-3, 5; CCO-4, 5, 6, 7, 8, 9, 10, 11, 12
B-1.2 Climate	B-1.21 A change in the climate would result in a modification of the landscape.	B-1.21	Relate to topic VIII. PIO-3, 5; CCO-4, 6, 7, 8, 9, 11, 12
	B-1.22 Some landscapes contain evidence of having developed under conditions of climatic extremes such as arid and glaciated regions.	B-1.22	Relate to topic VIII. PIO-3, 5; CCO-4, 6, 7, 8, 9, 11, 12
	B-1.23 The rate at which landscape development occurs may be influenced by the climate.	B-1.23	Relate to topic VIII. PIO-5; CCO-4, 6, 7
	B-1.24 The steepness of hillslopes in an area is affected by the balance between weathering and removal of materials.		PIO-1, 2, 5; CCO-6, 7, 8, 11, 12
	B-1.25 Other factors being equal, hillslopes which have evolved in a dry climate tend to differ in appearance from hillslopes which have evolved in a humid climate.	B-1.25	Relate to topic VIII and topic IX. PIO-5; CCO-4, 6, 7, 8, 11, 12
	B-1.26 Stream characteristics are affected by the climate.	B-1.26	Relate to topic VIII and topic IX. PIO-1, 5; CCO-4, 7, 8, 11, 12
	B-1.27 Soil associations differ in composition depending on the climate.	B-1.27	Relate to topic IX. PIO-5; CCO-4, 6, 7, 11, 12
B-1.3 Bedrock	B-1.31 The rate at which landscape development occurs may be influenced by the bedrock.		PIO-2, 5; CCO-6, 7, 11, 12
	B-1.32 The shape and steepness of hills are affected by the local bedrock composition.		PIO-2, 5; CCO-6, 7, 11, 12
	B-1.33 Competent rocks are responsible for plateaus, mountains, and escarpments, whereas weak rocks usually underlie valleys and other low-level areas.	B-1.33	Relate to topic IX. PIO-5; CCO-7, 11, 12

TOPIC OUTLINE	MAJOR UNDERSTANDINGS	INFORMATION TO TEACHERS
	B-1.34 Structural features in bedrock, such as faults, folds, and joints, frequently affect the development of hillslopes.	Relate to topic XII. PIO-5; CCO-7, 11, 12
	B-1.35 Stream characteristics are controlled by bedrock characteristics.	B-1.35 Relate to topic IX. PIO-2, 5; CCO-4, 6, 7, 11, 12
	B-1.36 Soil associations may differ in composition and are dependent upon the bedrock composition.	B-1.36 Relate to topic IX. PIO-5; CCO-4, 6, 7, 11, 12
B-1.4 Time	B-1.41 The duration of time during which environmental factors have been active will determine the stage of development or condition of a landscape region.	B-1.41 Relate to topics VIII, IX, X, and XIII. PIO-3, 5; CCO-6, 10, 11, 12
B-1.5 Dynamic equilibrium	B-1.51 A delicate balance of multiple environmental factors exists in all landscapes. A change in any of the factors results in a modification of the landscape and the establishment of a new equilibrium.	PIO-3, 5; CCO-1, 4, 5, 6, 7, 9, 11, 11, 12
B-1.6 Man		B-1.6 Activities or watches begun earlier on pollution may be summarized at this point. PIO-5; CCO-6, 7, 8, 9, 11, 12
	B-1.61 The activities of man have altered the landscapes in many areas.	
	B-1.62 The human population on the earth is increasing at an exponential rate.	B-1.62 The present doubling time is approximately 37 years. PIO-3, 5. PIO-5; CCO-6, 8, 9, 12
	B-1.63 Landscape pollution or misuse of the landscape is more critical to man in areas of high population density.	
	B-1.64 Man, with advanced technology, can inflict rapid changes on his environment that may produce catastrophic events as the environment adjusts to the stress.	CCO-6.
	B-1.65 Man's addition of pollutants to the atmosphere alters the rate of energy absorption and radiation which may result in a landscape-modifying climate change.	B-1.65 Relate to topics II, VII, and VIII. PIO-1, 2, 3, 5; CCO-4, 6, 7, 8, 9, 11, 12
	B-1.66 Resources, such as soil for agriculture, land for homesites, pure water for consumption and recreation, and clean air for biologic survival, can be conserved by careful planning and by the control of environmental pollutants.	B-1.66 Relate to topic II, VIII, and IX PIO-3, 5; CCO-1, 2, 4, 5, 6, 7
	B-1.67 Environmental conservation and planning programs may result in: a) elimination of landscape pollution and denudation b) reclamation of landscapes that have been misused	CCO-8
	B-1.68 Development of environmental conservation programs depends upon the awareness, attitudes, and action of the people.	CCO-12