



Curriculum Units by Fellows of the Yale-New Haven Teachers Institute  
2001 Volume II: Art as Evidence: The Interpretation of Objects

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## **Reading the Landscape: Geology and Ecology in the Nineteenth Century American Landscape Paintings of Frederic E. Church**

Curriculum Unit 01.02.01  
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### **Introduction**

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This curriculum unit uses nineteenth century American landscape paintings to teach high school students about topics in geography, geology, ecology, and environmental science. The unit blends subject matter from art and science, two strongly interconnected and fully complementary disciplines, to enhance learning about the natural world and the interaction of humans in natural systems. It is for use in The Dynamic Earth (An Introduction to Physical and Historical Geology), Environmental Science, and Advanced Placement Environmental Science, courses I teach currently at Wilbur Cross High School. Each of these courses is an upper level (Level 1 or Level 2) science elective, taken by high school juniors and seniors. Because of heavy emphasis on outdoor field and laboratory activities, each course is limited in enrollment to eighteen students. The unit has been developed through my participation in the 2001 Yale-New Haven Teachers Institute seminar, "Art as Evidence: The Interpretation of Objects," seminar leader Jules D. Prown (Yale University, Professor of the History of Art, Emeritus). The "objects" I use in developing unit activities include posters or slides of studio landscape paintings produced by Frederic Church (1826-1900), America's preeminent landscape painter of the nineteenth century, completed during his highly productive years of the 1840s through the 1860s. Three of Church's oil paintings referred to may also be viewed in nearby Connecticut or New York City art museums.

My selection of this topic for a curriculum unit to be used in science courses derives in part from a long-standing interest in American landscape painting. Nineteenth century American landscape painting has been known as the American School of Painting, the Native School, or the Hudson River School. The Luminist School is regarded as a derivative or continuation of Hudson River painting. Hudson River School is a term applied in the early years of the practice of this genre, first used as a derisive term but now accepted as a worthy (and unpejorative) descriptive term. I have been most inspired in my appreciation of American landscape painting by the works of Thomas Cole (1801-1848), Church, Asher B. Durand (1796-1886), John F. Kensett (1816-1872), Martin Johnson Heade (1819-1904), Sanford R. Gifford (1823-1880), Albert Bierstadt (1830-1902), and Thomas Moran (1837-1926). Of these landscape painters, Church stands out as my favorite artist, certainly for his artistic superiority but also for his chosen landscape subjects and localities, several of them places of special importance to me. Church's extensive travels took him to New York, New England, Canada, Mexico, the Caribbean, South America, Europe, the Mediterranean, and the Arctic so that he might familiarize himself with

the land and its natural features. He typically developed plein air sketches in watercolor or oil in the field and later sometimes much later produced studio compositions, some of them on a very grand scale, back at his New York City studio, or at his home studio at his Olana estate overlooking the Hudson River.

Those regions Church considered important to his own development of landscape painting to which I most closely relate are: the State of Maine, including its rocky coast as well as Mount Katahdin at the northern limits of the Appalachian Mountains (also geographically and topographically the beginning of the Allagash Wilderness Waterway, which I have canoed and studied for a period of twenty-five years); West Rock Ridge in the south central Connecticut Valley Lowlands (my principal research site for field biological work for nearly twenty years); Jefferson's Natural Bridge (not far from my family home in the Roanoke Valley of western Virginia); and various tropical locales in South America (which do not correspond with my travel experiences but appeal to my deep interest in tropical ecology).

I also have chosen the topic of American landscape painting for application to science education because I have long thought that the skills and abilities essential for understanding and appreciating natural features and natural processes (in geography, geology, ecology, and environmental science) are the same skills and abilities applicable to a close examination of paintings. People who work in science and in science education pursue their study and their communication about subject matter by observation (description, measurement, analysis), experimentation (manipulation, hypothesizing, predicting, testing), and theorizing (speculation, assimilation, unification, generalization). There is overlap in each of these pursuits. The use of hypotheses is central both to experimentation and to theorizing. Research may involve experimentation, but it also includes observation. As an example, much of molecular genetics today is fundamentally descriptive, although it places heavy reliance on experimentation.

For some time, I have made an effort to see Hudson River School paintings in art museums around the country: New York (Metropolitan Museum of Art); Boston (Boston Museum of Fine Arts); Connecticut (Hartford Atheneum, New Britain Museum of American Art, Yale University Art Gallery); Portland, Maine (Portland Museum of Art); Washington, D.C. (National Gallery of Art, Corcoran Gallery); Philadelphia (Philadelphia Museum of Art); San Francisco (The Fine Arts Museums of San Francisco); Seattle (Seattle Art Museum). I have had the fortune to see many of Frederic Church's most important paintings, in their home museums and in special exhibitions. I have developed a small library of publications on the Hudson River School, including monographs produced in conjunction with these special exhibitions on Frederic Church and on the works of other American landscape painters. However, much of the stimulus for writing this curriculum unit derives from my reading of three publications addressing the topics of ecology, geology, and American landscape art. The first of these, *A Sierra Club Naturalist's Guide: Southern New England* (Neil Jorgensen. 1978.) provides basic and practical advice for reading ecological landscapes. Jorgensen writes about recognizing plant and animal species by the communities in which they are found, understanding climate, interpreting evidence of glaciation, identifying forest fire burns and hurricane damage, seeing former land use practices in post-agricultural lands, and developing familiarity with representative species and keystone species for different habitats and ecosystems. His book, though nearly a quarter century old, is one of the most successful field guides that I have encountered for developing powers of observation in the field.

A second publication that I have found useful for training the eye to understand the natural world is Jerome Wyckoff's *Reading the Earth: Landforms in the Making* (1999). Wyckoff uses excellent quality photographs to discuss many of the major geologic processes of the dynamic Earth and the resultant appearance of landforms: rock types, weathering, the force of gravity, hillslopes, running water, igneous activity, mountains, plains and plateaus, glaciers, deserts and arid regions, coasts and shores, and the scenery of water-soluble

rocks. His book does for geology what Jorgensen's does for ecology.

Through the middle stages of the development of this unit, I have acquired a new publication that makes specific connections between nineteenth century American landscape painting and the subject of geology: *The Anatomy of Nature: Geology & American Landscape Painting, 1825-1875* (Rebecca Bedell. 2001.) Ms. Bedell, whose doctoral thesis advisor was Jules Prown, has conducted an important study of the "rich, complicated, and productive relationship" that existed in the mid-1800s between American geologists and American landscape painters. She writes of this collaboration, "both disciplines . . . were rooted in a careful observation of the natural world, and both were dedicated to illuminating the diversity and order of God's creation." She continues, "with a perception of their compatible methods and aims, geologists and landscape painters were able to collaborate in numerous social endeavors: promoting patriotism, spreading scientific knowledge, teaching moral lessons, inspiring religious awe, encouraging westward expansion, and fostering tourism." Her overview of the relation between science and the visual arts and her insights into the "higher meanings" of nineteenth century American landscape paintings have been a timely addition to my thinking about the subject matter of this curriculum unit, as has her chapter on Frederic Church.

Jules Prown's writings about material culture describe three stages of analysis, consisting of description (substantial analysis, content, formal analysis), deduction (sensory engagement, intellectual engagement, emotional response), and speculation (theories and hypotheses, program of research). I make use of this methodology in the unit by applying it to selected landscape paintings by Church depicting the subject matter of geography, physical geology, forest and wetland ecology, and issues in environmental science. While I do not focus here on the landscape paintings of Bierstadt, Durand, Moran, Kensett, Heade, Gifford, Cole, or other Hudson River/Luminist painters, my future development of the ideas in this unit will be extended to some of the landscape subjects treated by these American painters.

## Unit Objectives and Strategies

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Through the work of science curriculum committees over the past eight or so years, the New Haven Public Schools have developed and published a statement of Philosophy of Science, course Content Objectives, Performance Objectives, Course Outlines/Syllabi, and Assessment Measures for K-12 science education. To date, high school science course content and performance standards and related materials have been developed for integrated science, biology, chemistry, human physiology, physics, and environmental science. The newly implemented Advanced Placement Environmental Science (APES, College Board) curriculum is a national AP curriculum, and I am currently engaged in incorporating the APES curriculum into District curriculum publications, with elaboration based on my interests, experience, and strengths. This past year I introduced a new elective course to the New Haven high school curriculum, which I call The Dynamic Earth (Introduction to Physical and Historical Geology). I am developing content and performance standards for this geology course, based on the National Science Education Standards of the National Academy of Sciences (NAS), the Project 2061 Benchmarks and Content Standards of the American Association for the Advancement of Science (AAAS), and the New Haven District science curriculum. The New Haven science standards are derived in large part from NAS and AAAS science standards. In The Dynamic Earth, my students study the rock record and the geologic time scale, weathering and erosion, topography, the hydrologic cycle, rivers, deserts and arid regions, glaciers, ocean processes, atmosphere, volcanism, and global patterns and processes of the Earth. In Environmental Science, we are more directly concerned with forests, fields, wetlands, deserts, global

patterns of transfer of matter and energy, biological diversity, disturbance, and above all the interactions of humans with the natural environment and human-created environments. The Advanced Placement Environmental Science curriculum identifies six major topics for study (see APES Course Description, "Acorn Book"). They are:

Interdependence of Earth's Systems: 1) Fundamental Principles and Concepts (this unit incorporates the flow of energy; the cycling of matter; the solid Earth; the atmosphere; the biosphere) 2) Human Population Dynamics (this unit covers history and global distribution; carrying capacity local, regional, global; cultural and economic influences) 3) Renewable and Nonrenewable Resources: Distribution, Ownership, Use, Degradation (this unit addresses water; minerals; soils; biological; energy; land) 4) Environmental Quality (this unit deals with air/water/soil; solid waste; impact on human health) 5) Global Changes and Their Consequences (this unit treats first-order effects (changes); higher-order interactions (consequences)) 6) Environment and Society: Trade-Offs and Decision Making (this unit looks at economic forces; cultural and aesthetic considerations; environmental ethics; environmental laws and regulations (international, national, and regional); issues and options (conservation, preservation, restoration, remediation, sustainability, mitigation).

The text used in The Dynamic Earth is *Earth* (W.H. Freeman: Press and Siever), and the course readings come additionally from *Nature*, *Science*, *American Scientist*, *Scientific American*, *The New York Times Science Times*, and other science current events publications. A supplementary text for The Dynamic Earth is *The Dynamic Earth: an Introduction to Physical Geology*, Fourth Edition (Wiley: Skinner and Porter). The APES text is *Living in the Environment: Principles, Connections, and Solutions* (Wadsworth: Miller). The Environmental Science text is *Environmental Science: The Way the World Works* (Prentice Hall: Nebel and Wright). Both environmental science courses draw heavily from science journals such as those listed above and from current events. Most of my previously developed Teachers Institute curriculum units have been written for the environmental science courses.

The specific objectives that I have identified for this curriculum unit are, as indicated above, closely matched with national science education standards. While I cannot provide an in-depth listing of content standards in this document (although I have them in unpublished form), some reference to unit topics which apply to national and district content standards is in order. I have developed this unit in keeping with the National Academy of Sciences/National Research Council recommendation ( *National Science Education Standards* ) that science education place more emphasis on: "understanding scientific concepts and developing abilities of inquiry; learning subject matter disciplines in the context of inquiry, technology, science in personal and social perspectives, and history and nature of science; integrating all aspects of science content; studying a few fundamental science concepts; and implementing inquiry as instructional strategies, abilities, and ideas to be learned."

The unit relates in particular to the following NAS/NRC content standards:

Content Standard: K-12. All students should develop understanding and abilities aligned with the following concepts and processes: systems, order, and organization; evidence, models, and explanation; constancy, change, and measurement; evolution and equilibrium; form and function.

Content Standards: 9-12. A. All students should develop abilities necessary to do scientific inquiry, and understandings about scientific inquiry. Physical Science: Content Standard B. All students should develop an understanding of: structure and properties of matter; motions and forces; conservation of energy and increase in disorder. Life Science: Content Standard C. All students should develop understanding of: biological evolution; interdependence of organisms; matter, energy, and organization in living systems. Earth and Space

Science: Content Standard D. All students should develop an understanding of: energy in the earth system; geochemical cycles; origin and evolution of the earth system. Science and Technology: Content Standard E. All students should develop: abilities of technological design; understandings about science and technology. Science in Personal and Social Perspectives: Content Standard F. All students should develop understanding of: natural resources; environmental quality; natural and human-induced hazards; science and technology in local, national, and global challenges. History and Nature of Science: Content Standard G. All students should develop understanding of: science as a human endeavor; nature of scientific knowledge; historical perspectives.

I have also paid attention to science content standards as discussed in the American Association for the Advancement of Science (AAAS), Project 2061 publication, *Benchmarks for Science Literacy*. Chapter topics in this document which apply to the present unit are: the nature of science; the physical setting; the living environment; human society; the designed world; the mathematical world; historical perspectives; common themes; and habits of mind.

### **Hudson River School of Painting**

James Biddle, a former President of the National Historic Trust for Historic Preservation, is quoted as saying (Howat. 1972);

"throughout history the natural landscape has inspired the artistic expression of man. Thus it is not surprising that a region so richly endowed with great natural beauty as the Hudson River Valley should have produced countless individual works of art, poetry, and music. One of the most important contributions to the development of American artistic tradition is the work of a group of landscape painters of the last century known as the Hudson River School."

Biddle continued:

"regarding natural landscape as a direct manifestation of God, these men attempted to record what they saw as accurately as possible. Unlike European painters who brought to their canvases they styles and techniques of centuries, the Hudson River painters sought neither to embellish nor to idealize their scenes. They approached nature with reverence and portrayed it with the detailed care of a naturalist. Yet the results were more than photographically accurate."

The Hudson River and Luminist painters, who used light to greatest effect in their landscapes, did not limit their landscape paintings to New York State's famous Hudson River. Their inspiration came from such American landmarks as Niagara Falls and Kaaterskill Falls, from the Catskills and Berkshires of New York and Massachusetts, Lake George, the Green Mountains of Vermont and the White Mountains of New Hampshire, coastal and inland Maine, the salt meadows of eastern Massachusetts, the trap rock ridges of the Connecticut River Valley, Natural Bridge in Virginia, the vast landscapes of the American West (Rocky Mountains, Yellowstone, Yosemite, Sierra Nevadas), from Caribbean, Central American, and South American tropical and equatorial regions (Jamaica, Brazil, Ecuador, Peru, including the Andes Mountains), the frozen lands of the Arctic, as well as European and Near Eastern landscapes. Thomas Cole is recognized as the first nineteenth century American painter to devote his artistic abilities to portraying the American landscape in grand and mythic proportions, and he is credited with inspiring a group of American painters to extend the reach of the Hudson River School of painting throughout the Americas and to the Old World. His American and European landscapes were produced from the mid-1820s until his death in 1848. It was his student Frederic Church, however, who elevated American landscape painting to an art form comparable in technical artistry,

intellectual and emotional sophistication, and historical significance to the portrait paintings and historical paintings that previously defined the highest achievements of American painting.

After several decades of considerable artistic impact and great commercial success in the American art scene, Hudson River School landscape painting fell out of favor in the last quarter of the nineteenth century. Its revival in recognition as an expression of American art in its highest form has taken place in stages throughout the twentieth century, and especially since the early 1960s. Today, there is continuing scholarship in the historiography of this uniquely American genre of painting, providing fresh views of the Hudson River School and its painters. The paintings themselves have prominent display space devoted to them in museums around the country. New and insightful exhibitions focused on individual artists or providing important reexaminations of the works of several Hudson River artists are mounted on a seemingly regular basis. Accompanying catalogue publications now make available to students of the history of American painting a large body of writing on Frederic Church, his predecessors Cole and Durand, his contemporary "second generation" painters, and his successor landscape painters. Much of my preparation for the writing of this unit has been devoted to a reading of some of the recent literature on the Hudson River School of painting and to the critical examinations of Frederic Church's work in particular. I have paid particular attention to the writings of Church scholars Franklin Kelly and Gerald L. Carr, and I am aware that additional Church scholars whose writings I have not yet examined will continue to inform my appreciation of Church in the future. I have also devoted a considerable amount of time to my own detailed study of selected Church paintings at Yale Art Gallery, the New Britain Museum of American Art, and the Hartford Atheneum. I do not propose to attempt here a scholarly treatise on the Hudson River School or the works of Frederic Church. It is simply beyond the scope of this unit or my present time frame. Teachers who use this curriculum unit will need to do their own reading on nineteenth century American landscape painting and their own viewing of landscape pictures in order to provide necessary background for their teaching. In addition, I recognize that my consideration of oil sketches made by Church in preparation for his studio compositions would provide greater depth to my understanding (and my students' understanding) of his deep knowledge of natural history and more opportunities for meaningful teaching about the relation between art and science. The present unit is very much a work in progress.

### **Frederic E. Church's landscape paintings**

Church's painting of *West Rock* is recognized as his first great landscape combining an accurate representation of nature with "higher" artistic aspirations and meanings. I present here a sample methodological analysis of *West Rock, New Haven*, including the description and deduction stages of analysis. The third stage of analysis, speculation, is where this and other Church landscape paintings are examined for their scientific (geological and ecological) content and significance. While I have not produced a detailed write-up on the science content of *West Rock, New Haven*, I provide some guidance in the Classroom Activities section on how a class of students might undertake a program of research on each of the five selected paintings and read their artistic and scientific content.

## **Methodological Analysis:**

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***West Rock, New Haven (formerly Haying Near New Haven)*, 1849. New Britain Museum of**

## **American Art, Talcott Art Fund, 1950.10. Oil on canvas**

### *I. Description*

West Rock, New Haven is an oil painting on canvas measuring 27 1/8 inches by 40 1/8 inches. It hangs in a gilded wood frame that may be original to the painting. The landscape depicts fields, hedgerows, forests of deciduous and mixed coniferous trees, isolated trees in field margins, a stream, low and high ridges, animal-drawn carts, three men, a church steeple, and a cloud-streaked sky. There is some evidence of a dirt road near the center of the middle distance.

The two broad zones of land and sky divide the painting into unequal sections, 60% of the represented landscape occupied by sky and 40% by land. Clouds extend through much of the sky, with high and low cloud layers to the left and nearly uninterrupted cloud layers filling the sky to the right. The land occupies clearly defined foreground, middle ground, and distant background, with fields, hedgerows, the meandering stream, the carts, and men to fore and middle, and high ridge and rolling hills covered by forest and additional fields receding from view.

The narrow stream winds through right foreground and middle ground, partially obscured by a slight rise in the land. Wildflowers dot the far bank to either side of a cut tree stump, and water-lilies grow in a foreground portion of the stream. A small section of stream bank inclines down from the right. Trees and sky reflect from foreground stream waters. Two expansive fields lie to the left, separated from each other by a broken hedgerow and from the stream by groupings of medium-height trees. Trees and shrubs also border the left edge of the field in the foreground, one of them distinguished by spreading crown, broken top, and red foliage. Hitched with two oxen, a hay cart faces to the right a short distance from the stream. One man centers himself on the hay cart, balanced atop the cart's mounded hay pile, a pitchfork in hand. A second man, his back to the viewer, holds a rake to the ground while facing in the direction of this hay cart. Another hay cart bearing its load of hay stands partially obscured by trees to the left, as a third man sits on top of the pile, his rake protruding from the pile. The first man wears long, dark pants, a white shirt, and a tan hat with dark band and a wide brim. The second man wears long, brown pants, a white shirt with red sleeves, and a black hat with wide brim. The third man wears long, blue pants, a white shirt, and a tan, wide-brimmed hat. Two of the men wear suspenders. The man in the center is dark-skinned. The other men are lighter-skinned.

Each cart stands in front of a series of low hay piles arranged through the nearer field near the meandering stream. Flanked by the two carts, an oak tree spreads its branches wide, providing shade for a small red pail or basket and a small, white pitcher, resting side by side on the ground below. The painting is signed "F. CHURCH/1849" at the lower left, near a grouping of dark red boulders.

The middle ground and distance are more heavily forested than the foreground, yet are themselves interrupted by a series of open fields or meadows extending to the distant horizon. The tall ridge dominates the center of the landscape, divided equally into heavily forested ridge top and left slopes, and nonvegetated shear cliffs rising above an exposed talus slope. A white church steeple appears through the trees in front of the forested ridge. Above, a rich blue sky holds bands of cumulus and cumulostratus clouds. The clouds hang above the ridge top, and they extend far in the distance.

Long and short horizontals dominate the scene. No fewer than thirty bands of clouds demarcate the sky, with greatest layering above and to the right of the ridge. Several long shadows stretch across the fields, similarly banding the land. The long, low ridge of the middle ground is interrupted by the vertical cliff behind. Hay carts, men, tools, hay piles, and hedgerows constitute a strong foreground horizontal. Taken in order from

foreground to horizon, horizontal bands occur as shadow, sunlit field with carts, men, and hay piles, shadow, sunlit field, hedgerow, shaded field, low ridge, and high ridge. Vertical elements distribute through the scene less extensively, but they group tightly together and connect land with sky. A series of rock columns define the exposed cliff face, separating vertical groupings of clouds from the trees below. Sections of winding stream reflect the clouds in the sky above. The men in the field and the church steeple in the distance appear as small but prominent verticals.

Strong diagonals appear in the foreground oak's trunk, the three rakes, the stream meanders and stream banks, the steep talus slope and the less steep forested cliff slopes, and cloud margins. Circles, semi-circles, and ellipses reveal themselves in hay cart wheels, small hay piles, pail or basket, pitcher, men's hats, tree silhouettes, ridge profile, and clouds. Triangular elements include the church steeple, three separate portions of the stream, spaced apart by sloping land or by shadow, groupings of men and steeple, the crossed suspenders of two men, tree groupings, and clouds. Rectangles and rhomboids form from hay piled on carts, field lots, a small window in the church steeple, and the men's torsos.

Landscape materials and textures consist of rock (foreground rocks and cliff face), wood (trees and shrubs, also long tool handles and church steeple), plant fiber, water (stream and suspended cloud vapors), metal (tool heads and wagon wheel rims), cloth (men's garments), leather (oxen skin and harness straps), and horn. Predominant colors are blue sky, white, pink, and salmon clouds, light and dark green trees and shrubs, red cliff face, tan fields, hay mounds, and hay piles, white shirts, white church steeple, blue pants, red shirt sleeves, brown pants, brown cart wheels. Blues, whites, reds, and greens are most evident. Greatest light intensity and strongest color values are seen in the men's white shirts and their left-facing sides, the church steeple, the tops of the hay mounds, the reflecting waters of the stream, the cliff face and talus slope, the sunlit fields, and the tops of billowing clouds. The single greatest light intensity appears on the church steeple.

## *II. Deduction*

Frederic Church's *West Rock, New Haven* (1849) stimulates the senses in a variety of ways, presenting diverse sights, sounds, smells, tastes, and senses of touch. Three men pile newly cut hay onto two hay carts in a hedgerow-bordered agricultural field beside a gently flowing, meandering stream. A basaltic trap rock ridge looms in the center background. Its lower slopes hold a mosaic of agricultural fields, bordered by forest and extending into the distance at left. A church steeple rises into view between the fields and the ridge, marking the location of an unseen village green. White clouds accented by angled sunlight pass across the field of view. The picture presents a rich mingling of colors: bright yellow-greens of hay fields, rich dark greens of mixed hardwood forest, soft blue skies patched by billowing cumulus clouds and reflected in smooth-flowing waters, and bold red cliffs rising near-vertically above a steeply angled talus slope.

In the scene, areas of movement contrast with areas of stasis. Of the three men, the central figure draws his rake across the mowed field and prepares a mound of hay for transfer to the cart. His fellow worker atop the hay cart uses a pitchfork to level the hay pile and complete the load. Two oxen stand impassively and await further commands to haul the filled hay cart away. A second cart to the left already is filled, and its farm hand has jabbed his fork into the completed pile and assumed a seated position atop the hay. He looks at his co-workers, awaiting the completion of their task and an end to the day's work. Shadows lengthen across the fields as late afternoon gives way to early evening. The stream flows south from distant hills, disappearing from view in the right foreground. Westerly winds carry clouds from left to right across the field of view, which is generally to the north and east. Tree leaves blow gently in the sporadic breezes, the tree boles anchored securely to their soils. The church steeple breaks the tops of the surrounding trees, fixed on a firm foundation.



Cliff face and talus slope maintain a tenuous equilibrium, balancing short term stability with longer term dislodging, falling, and accumulation of boulders, cobbles, and pebbles.

A superficial stillness is punctuated by quiet sounds that emanate from throughout the depicted scene. The man with rake in hand breathes heavily from his extended exertions, while the oxen force snorting exhalations and gastrointestinal murmurs. Occasional verbal commands help to keep the animals steady. Water flows in riffles across a shallow bar in the foreground portion of the stream. The far-off cliff hides periodic rattles of falling rock. We await the next ringing of the church steeple's bell.

The heat of the day gives way to cooling breezes. Lingering memories and expectant thoughts of drinking water and food are directed toward the basket and pail resting below the wolf tree oak standing back from the edge of the nearest field. The workers' backs are tired, their hands are sore, and their feet ache in their snug boots. Suspenders lighten the weight of work pants, but clothing still clings to sweaty bodies. The weight of tired brows masks a sense of accomplishment for a full day's productive work.

The scene is of a late afternoon or early evening in mid-summer in the central valley lowlands of southern New England. In a region of four distinct, changing seasons, this is the hottest portion of the annual cycle. This is the time for harvesting the fields of hay. It is one of the three cuttings these fields will receive. While the workers in the foreground enjoy cooling breezes mitigating the heat of day, the exposed cliff in the background is blasted with much stronger, steady gusts. Powerful updrafts of air at the ridge top are not hinted at on the more gentle slopes that recede from view on the eastern side of the ridge. The ecological time scale depicted includes warm air rising to create thermals over the ridge, blowing breezes and passing clouds, flowing water and minor sediment transport, a peaking of biomass production in terrestrial and palustrine habitats, and an agricultural harvest measured in terms of the annual cycle of seasons.

From a geological perspective, agents of change shape and have shaped this environment. They include the weathering and erosion of upland rocks to form sedimentary bedrock in this faulted river valley (the red rocks discerned in the left foreground consist of New Haven arkosic sandstone), intrusive deposits of magma welling up from the earth's mantle (seen now in the basaltic ridge and its columnar structure), erosive forces of a stream that downcuts the sedimentary layers while meandering across its floodplain, continually changing direction of flow, and depositing nutrients to further enrich the soils, and the mass wasting of the fractured cliff face, due to columnar jointing, freeze-thaw action in winter, and the inexorable pull of gravity to build up a substantial talus slope on its western margins.

Cycles dominate the scene. The cycle of seasons is depicted in the harvest. The rock cycle of igneous (plutonic magmas), sedimentary (depositional material), and metamorphic (transformed by temperature and pressure) rock types is represented in different portions of the picture. Components of the hydrologic cycle occur as clouds, humidity, and flowing stream. The hydrologic cycle involves the world of human activity, as well: pitcher of water, intake into men's bodies, perspiration and evaporation to the atmosphere. The carbon cycle is present in the various stages of carbon fixation (production of photosynthate by green plants) and carbon release (through animal respiration), and in the anticipated leaf abscission of the approaching autumn season.

Ecological disturbance also dominates the scene. Formerly extensive forest lands have given way to the development of agricultural fields. Natural and human-induced fire regimes occur. Stream banks are undercut by periodic flooding of the meandering stream. Seasonal storms such as nor'easters occur, as does periodic drought. Erosion and mass-wasting occur in uniform and catastrophic events and time scales.

We viewers are positioned on a rise above the fields, witnesses to the developing relationship of man and

nature. We are here as passive observers, but we can receive instruction from the depicted scene. Although we are above the fields, we are well below the lofty heights of the cliffs and ridgeline in the background. We stand on the right bank of the stream, although an unseen meander of the stream may place us to the left. The rise that we stand on is seen in the red outcrop of rocks in the left foreground. It is thus unclear if we need to cross the stream in order to reach the hay carts and workers. Much has occurred prior to this moment: clearing of fields, growing of hay, cutting hay with hand-held scythes, piling of hay on the carts, a lunch break or rest from labors, and in a longer time span the establishment of an agrarian society. At least one of the workers, the central figure with rake in hand, is a black man. All three men are farm hands employed to work the fields and harvest the crop. Earlier, they set out from a farm with empty carts, heading to their fields of toil. Shortly, they will return to the nearby farm and its barns to deliver their harvest. The hay they have gathered will feed domesticated animals (horses, cows, sheep, oxen). It will be used as a saleable crop in the local economy an agrarian economy.

The emotional response elicited by this scene includes reverence for the bounty of nature, awe of the natural beauty on the environment, satisfaction with a bountiful harvest, and caution about the various sources of disturbance that periodically and regularly intrude on this seemingly harmonious setting. It includes an appreciation of history encompassing Native Americans, colonials, and Americans living in a young nation, a sense of mystery and curiosity about the biological richness of the region, and a sense of concern about the great potential for overexploitation of natural resources. This is a time period that still is characterized by a sense of sustainable development and sustained yield. Yet, it suggests a loss of wilderness, a loss of habitat and species diversity, changing land use practices, changing flora and fauna, and changing ecological dynamics. As West Rock Ridge has been the focal point of my field research for the past twenty years, I am drawn into the scene and wish to travel through it.

## Classroom Activities

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### 1. Methodological analysis of Frederic E. Church paintings

Five landscape paintings by Church have been selected for in depth examination. Students use the methodology described by Prown (1982) to interpret these paintings for artistic, historical, and scientific content and to develop an understanding of aspects of nineteenth century American culture. The paintings are: *West Rock, New Haven* (1849); *The Natural Bridge, Virginia* (1852); *Mt. Ktaadn* (1853); *Heart of the Andes* (1859); and *Cotopaxi* (1862). Prown (1982) writes that "analysis proceeds from description, recording the internal evidence of the object [painting] itself; to deduction, interpreting the interaction between the object and the perceiver; to speculation, framing hypotheses and questions which lead out from the object to external evidence for testing and resolution."

In the descriptive stage, students study the paintings for their internal content and evidence. They begin with "substantial analysis," in which the paintings' physical dimensions, extent of use and distribution of materials, and articulations are noted. The paintings are then analysed for their content, beginning with the broadest description of the various elements of the paintings and proceeding to more detailed consideration of these elements. Then, the "visual character" of the paintings is considered, beginning with two-dimensional organization, moving to three-dimensional configurations, and to such formal elements as color, light, value, and texture.

In the deductive stage, students engage each painting through sensory, intellectual, and emotional interactions, bringing to bear their own experiences, thoughts, and feelings. Here, they search for "unrestrained interpretations of the evidence elicited by the description," all the while offering deductions which remain reasonable in light of the descriptive evidence. Sensory engagement includes consideration of the stimuli the viewer would experience if placed in the world of the painting: sight, sound, smell, taste, touch. Intellectual engagement requires the viewer to ask questions of the paintings and seek reasonable answers, as for example the time of day, season of year, features of defined space, and actions in the paintings at the depicted moment, just before, and just after the moment represented. Finally, the emotional engagement of the viewer to the painting is sought, with an effort to define the full range of emotional interaction with the depicted scene both positive and negative emotional reactions.

The speculative stage of analysis enables the viewer (the student) to give free reign to his/her thinking about these landscape paintings, the desired outcome being "as much creative imagining as possible, the free association of ideas and perceptions." The evidence derived from descriptive and deductive examination leads to the development of hypotheses about the overt and the subtle, the objective and the subjective, the conscious and the unconscious currents which run through and comprise the painted landscapes and their artistic, historical, moral and spiritual, and scientific content and meaning. A program of research is then defined and outlined as a way of checking the validity of the speculative inferences drawn from the art works. The research program that follows places greatest emphasis in this curriculum unit on gaining knowledge of concepts in geological and ecological sciences by focusing on current and historical writings from the scientific literature.

## **2. Program of research review of the scientific literature**

The scientific research component of the speculative stage will be particularly useful in informing us as to the usefulness of considering landscape paintings to introduce the study of scientific concepts in geology and ecology. I develop here a brief outline of the directions my students take in seeking to understand the scientific content of each of the selected Frederic Church paintings.

### ***West Rock, New Haven (1849)***

West Rock Ridge has received extensive scientific study by geologists and ecologists over the course of the last two hundred years. There is a considerable body of early material published on the geology of West Rock and its associated trap rock ridges (Pine Rock, Mill Rock, and East Rock). Students are given access to reprinted material from the writings of the nineteenth century geologists Benjamin Silliman and James Dwight Dana of Yale, and James Percival, Connecticut State geologist of the middle portion of the last century (see Davis. 1898.). Twentieth century research on the southernmost trap rock ridges of the Central Valley includes material published in Connecticut State Geological and Natural History Survey Guidebooks and Yale geology course materials for fieldtrips in Connecticut, which I have assembled and included in my geology classroom library. Ecological work on West Rock dates to the early years of the twentieth century with the writings of George E. Nichols (Yale Forestry School) on trap rock upland ecology. West Rock is recognized as having the second highest concentration of rare and endangered plant and animal species in the state of Connecticut. Numerous studies have been carried out on West Rock habitat types, plant life, and invertebrate and vertebrate animal life, and I have been assembling this published information for the West Rock Ridge Park Association, supported by funding from the Connecticut Department of Environmental Protection, Natural Resources Protection Project.

With the input of various members of the Connecticut Botanical Society, I have developed a preliminary list of the herbaceous and woody plants of West Rock Ridge. I have prepared a list of some 240 species of birds

found at West Rock (60% of the state avifauna), including nearly 70% of all bird species known to breed in Connecticut. I also have comprehensive data on National Audubon Society/New Haven Bird Club Christmas Bird Counts and Summer Bird Counts since the inception of these counts, with specific information on the birds of West Rock Ridge, what we call Area C of the counts. My own field work at West Rock has focused on the amphibians, reptiles, and mammals of the ridge, in addition to my study of breeding birds. The materials I have collected on West Rock serve as the basis for the students' research on Frederic Church's painting of this New Haven landmark and its scientific significance.

Geology topics to be explored by my students include: plate tectonics; faulting; rock types (igneous and sedimentary); volcanic (extrusive) and plutonic (intrusive) igneous rocks; columnar basalt; trap rock ridges and talus slopes; gravitational disturbance; glacial topography; meandering rivers and river erosion; floodplains. Ecology topics include: habitat types and biotic zonation; ridgetop habitats (xeric soils); slope habitats (mesic); floodplain/lowland habitats (hydric soils); rare and endangered plants and animals; breeding biology; adaptation; taxonomy; island biogeography.

### ***The Natural Bridge, Virginia , 1852***

The Natural Bridge figures prominently in historical writings dealing with Virginia's topographic landmarks (see University of Virginia Library website for a key exhibit on "Landmarks of American Nature Writing."). The College of William and Mary has an excellent website on the geology of Virginia, and this is the primary source of information for us on geology of The Natural Bridge in Virginia's valley and ridge geologic province. Our attention to ecological subject matter will take into consideration the distributions of "southern" species of vertebrates and invertebrates, based on an examination of scientific literature I have recently begun to collect.

Geology topics addressed include: geologic map of Virginia; physiographic map of Virginia; tectonic history of Virginia, including orogeny (mountain-building, fold and thrust belts); valley & ridge province; karst topography (natural bridges, sinkholes, caves, and underground drainage systems); natural hazards; economic geology. Ecology topics include: Eastern deciduous forest (oak-chestnut and oak-pine-hickory forest); southern species distributions; rare and endangered riverine habitat/species.

### ***Mt. Katahdin , 1853***

My brief search for scientific literature on Mount Katahdin has led to the identification of several key publications on Katahdin geology. Mt. Katahdin is at the northernmost end of the Appalachian Mountain chain and the Appalachian Trail. The Maine Department of Conservation, Maine Geological Survey literature available through the Worldwide Web contains some useful information on Katahdin geology. A useful source of information on Katahdin ecology is found in Bennett (1988).

Geology research topics on Katahdin include: glacial geology (the "Ice Age," continental ice sheets, glacial recession, cirque basins, arêtes, alpine glaciers, glacial valleys, moraines, glacial lakes, glacial topography); igneous rock types; geological time scale; erosion; climatology. Ecology topics include: alpine ecology; island biogeography; plant zonation; rare and endangered species.

### ***Heart of the Andes , 1859***

I have not yet collected extensive information on South American geology and ecology. (The Cocha Cashu in the Amazon of Peru is a region that has seen considerable field ecological study.) However, I have a library of pertinent information on tropical geology and tropical ecology of Central America, including classic studies of neotropical ecology at Barro Colorado Island (Panama), La Selva rain forest (Costa Rica), Monteverde tropical cloud forest (Costa Rica). Further investigation of Ecuadorian geology and ecology will undoubtedly turn up

key references that can be made available to my students. Church did careful studies of South American flora and fauna in preparation for his paintings of neotropical landscapes. My library holdings in the birds of Mexico and Northcentral America, Costa Rica, Colombia, and Venezuela will provide assistance in identifying bird species depicted by Church.

Geology topics for study include: climate; geomorphology (study of landforms); tropical soils; nutrient cycling. Ecology topics include: tropical plant and animal communities; altitudinal zonation; density and dispersion of forest trees; biological diversity; life history strategies; plant-herbivore interactions; frugivory; agricultural/forestry systems.

### **Cotopaxi , 1862**

Church's painting of the volcanic cone Cotopaxi, one of the most active volcanoes of the Andes mountain chain in historic times, is a strikingly visual representation of a catastrophic geological event. An idealized image of Andean topography, it is nevertheless a valuable teaching aid for patterns and processes in geological and ecological sciences.

Geology topics include: volcanism; orogeny; hot spots ("Ring of Fire"); volcanic rock and volcanic deposits; eruptive styles; volcano topography; case histories of volcanic eruptions; economic impacts. Ecology topics include those listed under *Heart of the Andes* .

### **3. Program of research flora and fauna in field and laboratory**

In my science teaching, I place emphasis on hands-on laboratory and field experiences. An important aspect of the teaching of this unit is the study of a rock and mineral study collection and fresh plant material and live animals as a way of seeing the pertinent geology and the living organisms that inhabit (some of) the natural landscapes depicted by Frederic Church. Given our location, this is most easily done for the geology and the biota of West Rock. I have assembled a teaching collection of rock types (West Rock dolerite, New Haven arkosic sandstone) from West Rock. I have samples of volcanic rocks (tuffs and vesicular basalts) from the volcano fields of northcentral New Mexico. I will have collected representative rock samples from Mt. Katahdin area for my first use of this unit. And, I have expectations that limestone rock samples from Natural Bridge, Virginia will be obtained shortly.

At various times during the teaching of the unit (and based on their seasonal availability), I bring in samples of plant and animal life from West Rock habitats: upland, slope, and floodplain. Students use field guides to help in the identification of species, and they make observations on structural adaptations and learn about physiological and behavioral adaptations. As part of their examination of representative biota, students prepare a series of sketches of the plants and animals they see in the laboratory.

## **Annotated Teacher Bibliography**

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Bedell, Rebecca. 2001. *The anatomy of nature: geology & American landscape painting , 1825-1875*. Princeton, New Jersey: Princeton University Press, 186pp. Introductory chapter on "the alliance between geology and landscape painting" and the popularity of geology in nineteenth century American society. Chapter Three: Frederic Church and the Educational Enterprise. Scholarly interdisciplinary work in art history, history of science, and American cultural history.

Carr, Gerald L. 2000. *In search of the Promised Land: paintings by Frederic Edwin Church* . New York: Berry-Hill Galleries, Inc., 204pp. Published in conjunction with the exhibition, which traveled from New York to Chicago, Portland, Oregon, and Portland, Maine (25 April 2000 - 18 March 2001). I regrettably missed it both in New York and Portland, Maine. Significant sections on Church's love of nature and his extensive travels, the influence of Alexander von Humboldt, Church's landscapes from the eastern United States, the Caribbean and South American tropics, and the Arctic, and his Olana estate.

Cooper, James F. 1999. *Knights of the brush: the Hudson River School and the moral landscape* . New York: Hudson Hills Press, 109pp. "Iconic works by Frederic Edwin Church . . . and others are examined in relation to the religious, moral, and aesthetic sensibility that underlies their work." Cooper writes, "let us begin this great task [of choosing life] by enlisting gifted artists to help us see once again." A powerful message, when taken in conjunction with Niles Eldredge's view that "religious traditions, especially as embodied in concepts of God, are deeply if not wholly ecological concepts as well." (Eldredge, Niles. 2000. *The triumph of evolution and the failure of Creationism*. New York: W.H. Freeman and Company, 223pp.)

Davidson, Marshall B., and Elizabeth Stillinger. 1985. *The American Wing at the Metropolitan Museum of Art* . New York: The Metropolitan Museum of Art/Alfred A. Knopf, 352pp. The chapter called "The Mid-Nineteenth Century: 1840-65" discusses Met holdings by Cole, Durand, Inness, Heade, Lane, Kensett, Church (Heart of the Andes), and Bierstadt.

Davis, William M. 1898. *The Triassic formation of Connecticut* . Washington, D.C.: Government Printing Office. Eighteenth Annual Report of the United States Geological Survey to the Secretary of the Interior, 1896-97. Part II. Papers chiefly of a theoretical nature. Pp. 1-192. Refers to early studies of Connecticut Valley Lowland and West Rock by James Dwight Dana and Benjamin Silliman of Yale. Comprehensive discussion of (our early understanding of) Central Valley trap rock ridges. Interesting late nineteenth century photo of West Rock cliff face.

Doezema, Marianne, and Elizabeth Milroy, eds. 1998. *Reading American art* . New Haven, Connecticut: Yale University Press, 470pp. The text for the YNHTI seminar. Excellent chapter contributions, including Alan Wallach's "Thomas Cole and the Aristocracy," Roger Stein's on Charles Willson Peale, and Prown's on "Winslow Homer in his Art."

Flint, Richard Foster. 1965. *The surficial geology of the New Haven and Woodmont quadrangles* . Hartford, Connecticut: State Geological and Natural History Survey, Department of Agriculture and Natural Resources, Quadrangle Report No. 18. Sections on bedrock geology, topography, glacial geology, glacial/postglacial history, and economic geology. Enclosed map clearly shows trap rock ridges of West Rock, Pine Rock, Mill Rock, and East Rock-Indian Head-Snake Rock.

Harvey, Eleanor Jones. 1998. *The painted sketch: American impressions from nature, 1830-1880* . Dallas: Dallas Museum of Art, 299pp. Discusses the outdoor or plein air oil sketches landscape painters produced as studies for their "finished" studio compositions. Considers Church's use of outdoor sketches and his display and marketing of them. Catalogue devotes 38 pages to Church's sketches of Katahdin, Niagara Falls, Cotopaxi, Chimborazo, icebergs, tropical plants.

Howat, John K. 1972. *The Hudson River and its painters* . New York: The Viking Press, 208pp. Introductory overview of the Hudson River School and its most important artists. Reprint of 1894 Wallace Bruce map of Hudson River. Depicts and describes 100 paintings of Hudson River and environs, including Church oil sketches of Hudson River from Olana.

Johns, Elizabeth, Andrew Sayers, Elizabeth Mankin Kornhauser, and Amy Ellis. 1998. *New worlds from old: 19th Century Australian & American landscapes* . Canberra, Australia & Hartford, Connecticut: National Gallery of Australia & Wadsworth Atheneum, 271pp. Background reading on American landscape painting. Catalogue for the exhibition, at Wadsworth Atheneum, 12 September 1998 - 4 January 1999, which included Church's *West Rock, New Haven* .

Kelly, Franklin. 1989. *Frederic Edwin Church* . Washington, D.C.: National Gallery of Art, 211pp. Catalogue for the National Gallery of Art exhibition of 8 October 1989 - 28 January 1990, *Frederic Edwin Church* , which I viewed in Washington during its run. Essays by

Kelly on Church's "passion for landscape," James Anthony Ryan on Olana, and especially Stephen Jay Gould's essay, "Church, Humboldt, and Darwin: The Tension and Harmony of Art and Science" have been essential for my developing understanding and appreciation of Church's landscapes. Contains a chronology of Church's life and work and the unfinished biography by Charles Dudley Warner.

Kelly, Franklin. 1988. *Frederic Edwin Church and the national landscape*. Washington, D.C.: Smithsonian Institution Press, 179pp. "The subject of this book is the sequence of North American landscapes that Frederic Church created between 1845 and 1860, which I propose should be seen as a series of national images that addressed matters of pressing importance and interest to the American nation." One of this unit's most important sources of information. *West Rock, New Haven* is on the book cover.

Koja, Stephan, ed. 1999. *America: the New World in 19th-Century painting*. Munich: Prestel Verlag, 296pp. Catalogue for the ambitious exhibition held in Vienna, 17 March - 20 June 1999. The chapter, "The Wilderness as a Source of American Identity," discusses Cole, Church, and Thomas Moran, and the influence of von Humboldt. The exhibition included Church's *Cayambe* (1858), *Twilight in the Wilderness* (1860), *Niagara Falls from the American Side* (1867), and *The Iceberg* (1891).

Metropolitan Museum of Art. 1987. *American paradise: the world of the Hudson River School*. New York: Metropolitan Museum of Art/Harry N. Abrams, Inc., 347pp. Catalogue for the 4 October 1987 - 3 January 1988 exhibition at the Metropolitan Museum of Art, which I viewed. Highly useful essays on historiography of the Hudson River School, the maturation of American landscape painting as an artistic genre of the highest order, the New York art scene of the middle portion of the nineteenth century, and the relation of the Hudson River School to competing European and American painting styles. A major source of information.

Nash, Roderick. 1982. *Wilderness and the American mind (Third Edition)*. New Haven: Yale University Press, 425pp. Classic scholarly study of "America's changing attitudes toward wilderness." Chapters and sections on the evolving concept of wilderness, influential American writers, artists, conservationists, ecologists, and political figures. Comprehensive historical overview of American wilderness excellent background. Several pages discuss Cole, Durand, Church, and Thomas Moran. (Key concepts for incorporation into lecture/discussion.)

Nutting, Wallace. 1923, 1935. *Connecticut Beautiful*. New York: Garden City Publishing Company, 256pp. Nutting writes, Connecticut "has no such extremes on contour as the more mountainous states of New England but her peculiar geologic formations, her extensive bound on Long Island Sound, her reach of highlands on the Connecticut, are of sufficient distinction to win attention and regard." The photograph opposite page 112, "Unloading the stack Nyack," showing oxen-drawn hay cart with workers and pitchforks makes very interesting comparison with Church's *West Rock, New Haven* picture.

Nutting, Wallace. 1930, 1935. *Virginia Beautiful*. New York: Garden City Publishing Company, 262pp. "Over three hundred pictures of landscapes and dwellings. Brief section on the geography of Virginia. From a series of Nutting books on eastern states.

Nygren, Edward J. 1986. *Views and visions: American landscape before 1830*. Washington, D.C.: The Corcoran Gallery of Art, 311pp. Background reading on pre-Hudson River School American landscape painting. Interesting Isaac Weld aquatint, *View of the Rock Bridge* (1798), presumably of Natural Bridge, Virginia.

Prown, Jules David. 1987. *American painting from its beginnings to the Armory show*. New York: Rizzoli International Publications, Inc., 134pp. Fifth chapter, The Search for Identity, considers the discovery of Thomas Cole's artistic genius, Church's "combined interest in art and the earth sciences," Heade's "intimate studies of the flora and fauna of the rain forests of Brazil," and the "new respectability" of American landscape painting.

Prown, Jules David. 1982. *Mind in matter: an introduction to material culture theory and method*. Wilmington, Delaware: Winterthur Portfolio, The Henry Francis du Pont Winterthur Museum, Pp. 1-19.

Von Humboldt, Alexander. 1834, 1995. *Personal narrative of a journey to the equinoctial regions of the New Continent* . Translated by Jason Wilson. London: Penguin Books. Continues to inform my understanding of Church's attraction to South America.

Von Humboldt, Alexander. 1845 & 1850, 1997. *Cosmos: a sketch of a physical description of the Universe (Foundations of Natural History)* . In two volumes. Specific reference to the Andean Cordillera, Chimborazo and Cotopaxi, climate and ecology, and vegetational zonation. Famous seventeen page section on "landscape painting in its influence on the study of nature."

Wadsworth Atheneum. 1992. "*The spirit of genius*": *Art at the Wadsworth Atheneum* . New York: Hudson Hills Press, Inc., 260pp. Depicts Thomas Cole's *Mount Etna from Taormina* (1843), made timely by the Summer, 2001 eruptions of Mount Etna. Also, Church's *Vale of St. Thomas, Jamaica* (1867).

## Annotated Student Reading List

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Avery, Kevin J. 1993. *Church's great picture: The Heart of the Andes* . New York: Metropolitan Museum of Art, 64pp. Detailed consideration of Church's greatest picture, *The Heart of the Andes* , his travel through Ecuador and Colombia, and the scientific, artistic, and moral/spiritual/religious significance of the painting. (Selected passages.)

Bell, Michael. 1985. *The face of Connecticut: people, geology, and the land* . Hartford, Connecticut: Connecticut Geological and Natural History Survey of Connecticut, Department of Environmental Protection, Bulletin 110, 196pp. Continues as the best general overview of the geology of Connecticut, with clear explanation of Central Valley faulting, sedimentary deposits, and intrusive trap rock ridges. A set of slide photographs and illustrations from the book has been obtained from state geologist Sid Quarrier. (Selected assigned pages.)

Bennett, Dean. 1988. *Maine's natural heritage: rare species and unique natural features* . Camden, Maine: Down East Books, 285pp. Chapter on alpine plant communities discusses the Katahdin Group of mountain peaks. Excellent overview of Maine's topography, geology, and ecology. (Selected assigned pages.)

Brantley, Steven R. 1995. *Volcanoes of the United States* . Washington, D.C.: United States Geological Survey, General Interest Publications, 44pp. Additional reference material on volcanoes.

Decker, Robert, and Barbara Decker. 1998. *Volcanoes (Third Edition)* . New York: W.H. Freeman and Company, 321pp. Good reference material on the Ring of Fire, the subduction zones encircling the Pacific Basin. (Selected assigned pages.)

Frye, Keith. 1986, 2001. *Roadside geology of Virginia* . Missoula, Montana: Mountain Press Publishing Company, 278pp. Useful section on the solubility of limestone/carbonate, applicable to Natural Bridge and nearby caverns. Would benefit from better indexing and use of road maps. (Selected assigned pages.)

Hamblin, W.K., and J.D. Howard. 1980. *Exercises in physical geology (Fifth Edition)* . Minneapolis: Burgess Publishing Company, 225pp. Contains useful exercises on igneous, sedimentary, and metamorphic rocks, aerial photographs and topographic maps, volcanic landforms, continental glaciation, and tectonic features of North America. Student reference text.

Jefferson, Thomas. *Notes on the State of Virginia* . (William Peden, editor.) 1982. Chapel Hill, North Carolina: University of North Carolina Press, 315pp. Jefferson's "commentary on the resources and institutions" of Virginia, and a "delineation of Jefferson's major philosophical, political, scientific, and ethical beliefs." He briefly describes The Natural Bridge of Virginia, "the most sublime of Nature's works." (Selected assigned pages.)



Jorgensen, Neil. 1978. *A Sierra Club Naturalist's Guide to Southern New England* . San Francisco: Sierra Club Books, 417pp. Excellent sections on "looking at the landscape," forest geography, forest ecology, postagricultural land, wetlands and watercourses, and animals of southern New England. (Selected assigned sections.)

Jorgensen, Neil. 1977. *A Guide to New England's Landscape* . Chester, Connecticut: The Globe Pequot Press, 256pp. Sections on bedrock geology, "the face of the land," and vegetation, with good information on Katahdin's alpine zone, cirques, and blowdowns.

Press, Frank, and Raymond Siever. 1998. *Earth (Fourth Edition)* . New York: W.H. Freeman and Company, 656pp. The text for The Dynamic Earth course. Following chapters are most pertinent: 2. The Rock Record and the Geologic Time Scale; 3. Rocks and Minerals; 4. Folds, Faults, and Other Records of Rock Deformation; 5. Weathering: The Decomposition of Rocks; 6. Erosion and Landscape; 15. Plutonism: The Formation of Igneous Rocks; 16. Volcanism

Skinner, Brian J., and Stephen C. Porter. 2000. *The dynamic Earth: an introduction to physical geology (Fourth Edition)* . New York: John Wiley & Sons, Inc., 575pp+appendices. Supplementary text. Well written, highly comprehensive, excellent photographs and graphics, and strong in supplementary instructional materials.

Smith, McKelden. 1998. *The Great Estates Region of the Hudson River Valley* . New York: Historic Hudson Valley Press, 64pp. Several pages on Olana State Historic Site/National Historic Landmark.

Thoreau, Henry D. 1864, 1972. *The Maine woods* . Princeton, New Jersey: Princeton University Press, 347pp. (Edited, with an afterword, by Joseph J. Moldenhauer) First section is on Mount Katahdin, here called Ktaadn.

Wyckoff, Jerome. 1999. *Reading the Earth: landforms in the making* . Mahwah, New Jersey: Adastra West, Inc., 352pp. "A book for all who enjoy natural scenery and wonder how it is made: a book also for earth-science teachers and students . . ." Numerous excellent photographs and descriptions of landforms, highly applicable to American landscape paintings.

## Classroom Materials

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Color slide, *West Rock, New Haven* , 1849, Frederic Edwin Church. New Britain Museum of American Art. Color slide set of details of *West Rock, New Haven* . (photographed May-August, 2001 by S.P.B., courtesy Mel Ellis, Director of Administration)

Poster, *The Natural Bridge, Virginia* , 1852, Frederic Edwin Church. (presently on order from Bayly Museum of Art, University of Virginia)

Poster, *Mt. Ktaadn* , 1853, by Frederic Edwin Church. Yale University Art Gallery/Wonderland Graphics, Inc., Grand Rapids, Michigan, 1995. (Image 17 ½" x 26 ¾"). Color slide set of details of *Mt. Ktaadn* . (photographed Summer, 2001 by S.P.B.)

Poster, *The Andes of Ecuador* , 1855, Frederic E. Church (1826-1900). Reynolda House Museum of American Art, Winston-Salem, North Carolina, 1984. (Image 15 3/16" x 24")

Poster, *Niagara* , 1857, by Frederic Edwin Church (American, 1826-1900). Corcoran Gallery of Art/Aaron Ashley Inc., Yonkers, N.Y., 1997. (Image 17 ¼" x 36") (Labeled *Niagara Falls* )

Poster, *Heart of the Andes* , 1859, by Frederick Edwin Church (American, 1826-1900). The Metropolitan Museum of Art/Aaron Ashley Inc., Yonkers, N.Y., 1982. (Image 13" x 24")

Poster, *Twilight in the Wilderness* , 1860, Frederic Edwin Church, American (1826-1900). The Cleveland Museum of Art/Bruce McGaw

Graphics Publication, 1995. (Image 19 ¾" x 32 ½")

Poster, *Cotopaxi*, 1862, Frederic Edwin Church (American, 1826-1900). The Detroit Institute of Arts/National Gallery of Art, Washington, 1989. From exhibition of October 8, 1989-January 28, 1990. (Image 23" x 40")

Color slide set, Olana State Historical Site/National Historical Landmark, the Frederic Edwin Church Estate, Hudson, New York (photographed June, 2001 by S.P.B.); West Rock Ridge State Park (drawing from my extensive collection of slides taken over the past twenty years); Mount Katahdin/Baxter State Park, Maine (photographic work done during August, 2001); Natural Bridge, Virginia (future photographic work); tropical ecology (slides taken in Puerto Rico, Yucatan peninsula, and Oahu and Kauai, Hawaii, supplemented with slides from New York Botanical Garden and Golden Gate Park, San Francisco). Geology slides of volcanoes and volcanically active regions: north central New Mexico Rio Grande Gorge; Bandelier National Monument (taken June, 2001), Snake River Plateau and Craters of the Moon National Park, Idaho (March, 1994; February, 2001), Mount Rainier, Washington (July, 1993); Honolulu, Hawaii (July, 1972).

Videotape, "Frederic Church's Olana," State of New York, Office of Parks, Recreation, and Historic Preservation, Monadnock Media, Inc., 1992.

New York Times, Metropolitan Desk series, "In Art's Footsteps, Landscape With Tourists," a Spring-Summer 2001 series of articles relating to Hudson River School paintings and Hudson River landscapes. Articles of May 27 (Sunday), June 7 (Thursday), June 20 (Wednesday), July 4 (Wednesday), and July 19 (Thursday) on landscape paintings by Jasper Francis Cropsey, Sanford Robinson Gifford, Alexander Helwig Wyant, John Frederick Kensett, and Martin Johnson Heade. Additional articles to be published.

Selected field guides from Peterson Field Guide Series (Eastern Forests, Mushrooms, Wildflowers, Trees and Shrubs, Reptiles and Amphibians, Birds, Mammals), National Audubon Society North American Field Guide Series (Rocks and Minerals, Mushrooms, Wildflowers, Trees, Reptiles and Amphibians, Birds, Mammals), Golden Guides (Wildflowers, Trees) from Classroom library.

Plant presses, Herbarium sheets and related materials (Ben Meadows, Forest Suppliers, Carolina Biological Supply Company).

## **Websites:**

A. West Rock Ridge State Park, Connecticut:

<http://dep.state.ct.us/>

<http://www.friendsctstateparks.net>

B. Mt. Katahdin/Baxter State Park, Maine:

<http://www.state.me.us/doc/parks> for Maine Department of Conservation, Bureau of Parks and Lands.

<http://www.state.me.us/doc/nrimc/nrimc.htm> for Maine Department of Conservation, Bureau of Geology and Natural Areas: Maine Geological Survey and the Maine Natural Areas Program. See especially:

Maine Geological Survey, Geologic Sites of the Month (January 1997, "Mount Katahdin"; November 1999, "Aerial photographs of Maine views from the sky"; January 2000, "Maine's glacial moraines: living on the edge"; May 2000, "A geological traverse along South Branch Pond Brook, Baxter State Park"; July 2000, "Old topographic maps: geological tools and records of history".

C. The Natural Bridge, Virginia:

<http://www.wm.edu/CAS/GEOLOGY/virginia/index.html> for The College of William and Mary, Department of Geology, The Geology of Virginia.

<http://www.naturalbridgeva.com> for The Natural Bridge of Virginia LLC.

<http://www.lib.virginia.edu/exhibits/nature/bridge.html>.

<http://www.lib.virginia.edu/exhibits/nature/> for University of Virginia Library, Special Collections Department, Exhibitions: "Landmarks of American Nature Writing from Virginia's Blue Ridge Mountains and Shenandoah Valley," exhibition of 27 April - 14 July 1997, catalogue by Daniel J. Philippon. See Chapter 11. The Natural Bridge, Chapter 12. The Springs, Chapter 13. The Caves.

### **Maps, Atlases, and Gazetteers:**

*Connecticut/Rhode Island Atlas & Gazetteer (First Edition)* . 1999. DeLorme, Yarmouth, Maine. Detailed topographic maps.

*The Maine Atlas and Gazetteer (Seventeenth Edition)* . 1994. DeLorme Mapping Company, Freeport, Maine.

DeLorme Street Atlas USA Version 4.0 for Windows. 1996. Freeport, Maine: DeLorme. "Detailed, street-level maps of the United States . . . highways, populated places, airports, rivers, lakes, mountains, parks and other points of interest."

DeLorme Topo USA 2.0 CD-ROM. 1999. Yarmouth, Maine: DeLorme. ([www.delorme.com](http://www.delorme.com)). For Windows 95/98. "Topo USA 2.0 is the only CD-ROM mapping software to include seamless topographic coverage for the entire United States." Maine, Connecticut, and Virginia all appear on the Northeast CD-ROM.

National Geographic Seamless USGS Topographic Maps on CD-ROM. Northeastern USA. 2000. San Francisco: Wildflower Productions.

Topo! Interactive maps on CD-ROM. Connecticut, Berkshires, and S. Green Mountains. 1998. San Francisco: Wildflower Productions. ([www.topo.com](http://www.topo.com))

What do maps show? [a teaching package]. Undated, ca. late 1990s. Washington, D.C.: United States Geological Survey, U.S. Department of the Interior.

Rodgers, John, Compiler. 1985. Bedrock geological map of Connecticut. Hartford, Connecticut: State of Connecticut, Natural Resources Center, Department of Environmental Protection (Connecticut Geological and Natural History Survey).

New Haven County, Connecticut. County Map Series (Topographic). 1980. United States Department of the Interior, Geological Survey/State of Connecticut, Department of Environmental Protection, Natural Resources Center. (Compiled from 1:24,000-scale maps.)

## Laboratory collections & specimens:

### *Rock samples:*

West Rock dolerite (basalt); New Haven arkosic sandstone; samples from Katahdin, Maine; igneous plutonic and volcanic samples from Rio Grande Gorge, Bandelier National Monument (Bandelier tuff), and Jemez Valley, New Mexico.

Freshly collected plant samples from West Rock Ridge State Park: Lake Wintergreen Red Maple Swamp (red maple, American larch, eastern white pine, sweet pepperbush, royal fern, sensitive fern, cattail, skunk cabbage, blue flag (iris), marsh marigold, sphagnum moss, various fungi); Ridgetop (chestnut oak, northern red oak, white oak, shagbark hickory, pignut hickory, mockernut hickory, various herbaceous plants); Talus Slope (black birch, bladdernut, herb Robert, red trillium, bloodroot, Christmas fern); Open Field (grasses, forbes and herbaceous plants).

### *Live animals:*

Spotted Salamander (*Ambystoma maculatum*) (from ridgetop vernal pool opposite Lake Dawson, or vernal pools at north end of West Rock Ridge), Redback Salamander (*Plethodon cinereus*), Red-spotted Newt (*Notophthalmus viridescens*), Eastern American Toad (*Bufo americanus*), Gray Tree Frog (*Hyla versicolor*), Green Frog (*Rana clamitans*), Pickerel Frog (*Rana palustris*), Wood Frog (*Rana sylvatica*), Common Snapping Turtle (*Chelydra serpentina*), Painted Turtle (*Chrysemys picta*), Spotted Turtle (*Clemmys guttata*), Wood Turtle (*Clemmys insculpta*), Eastern Box Turtle (*Terrapene carolina*), Common Musk Turtle (*Sternotherus odoratus*), Northern Black Racer (*Coluber constrictor*), Northern Water Snake (*Nerodia sipedon*), Eastern Garter Snake (*Thamnophis sirtalis*), recent photographs of Northern Copperhead (*Agkistrodon contortrix*). Also, representative mist-netted forest birds, if arrangements can be made with friends who are licensed bird banders. All vertebrates are kept in captivity for periods of no more than two days, then are released exactly where they were originally collected from the field.

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