

## **The Erie Canal's 200th Anniversary and the Map that changed the New World - Pioneering Geology Mapmakers across the Atlantic\***

**Charles A. Sternbach<sup>1</sup>**

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### **Abstract**

We draw historical analogy between Simon Winchester's story of William Smith (the first geologic map of England, 1815) with Amos Eaton (the first geologic map of NY and the New World (1818 cross section and 1822 map). Both pioneering efforts share similarities: canal digging creates fresh outcrops, need for geoscientists to evaluate local resources, canal pathways provide vital access to move fuel for the Industrial revolution and manpower to open isolated regions. Amos Eaton was a traveling lecturer who founded the Rensselaer School for Engineering (RPI, 1824). Like William Smith in England, Eaton suffered many hardships in his personal life. Field work and applied science differentiated the American model of education from pure science education of European traditions. Early graduates founded many state geological surveys in the US which provided energy, critical resources, paving the way to an improved way of life. Many AAPG Eastern Section members will remember Gerald M. Friedman, a modern day Amos Eaton, and a keeper of the flame for practical geoscience education.

# The Erie Canal's 200<sup>th</sup> Anniversary and the Map that changed the **New World** ---Pioneering Geology Mapmakers across the Atlantic

by Charles A. Sternbach  
President AAPG, 2017-2018



# AAPG



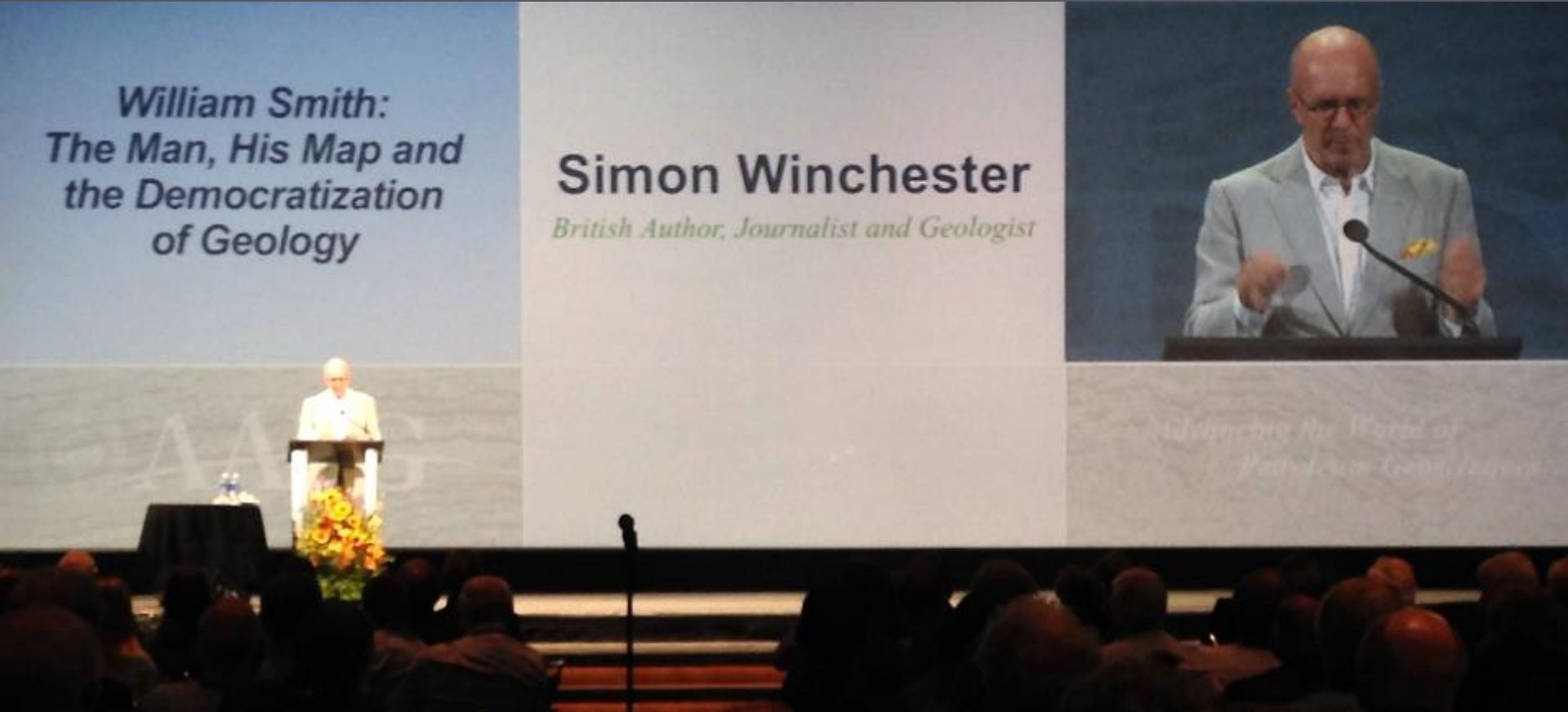
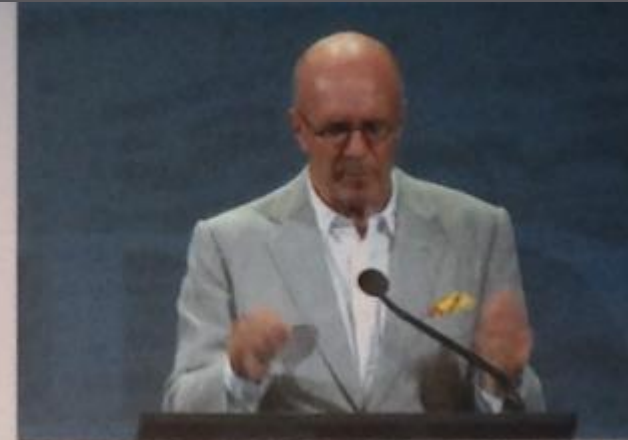
# Outline

- William Smith, British geologic hero, ignored but redeemed at the end (1769-1839)
- Simon Winchester, story teller about Wm Smith, author of The Map that Changed the world 2001
- Winchester built on the work of smith Historian Hugh Torrens
- Amos Eaton, American Scientist, innovative educator, field geologist (1776-1842) contemporary of Wm Smith
- The Story of Amos Eaton rarely told

# The British start Geology Field Mapping

*William Smith:  
The Man, His Map and  
the Democratization  
of Geology*

**Simon Winchester**  
*British Author, Journalist and Geologist*



AAPG All Convention Luncheon  
Denver, Monday June 1, 2015

# The British Team

**William Smith, Geologist**

**John Cary, Mapmaker**

**Charles Lyell, Geologist**



**1769-1839**



**1754-1835**

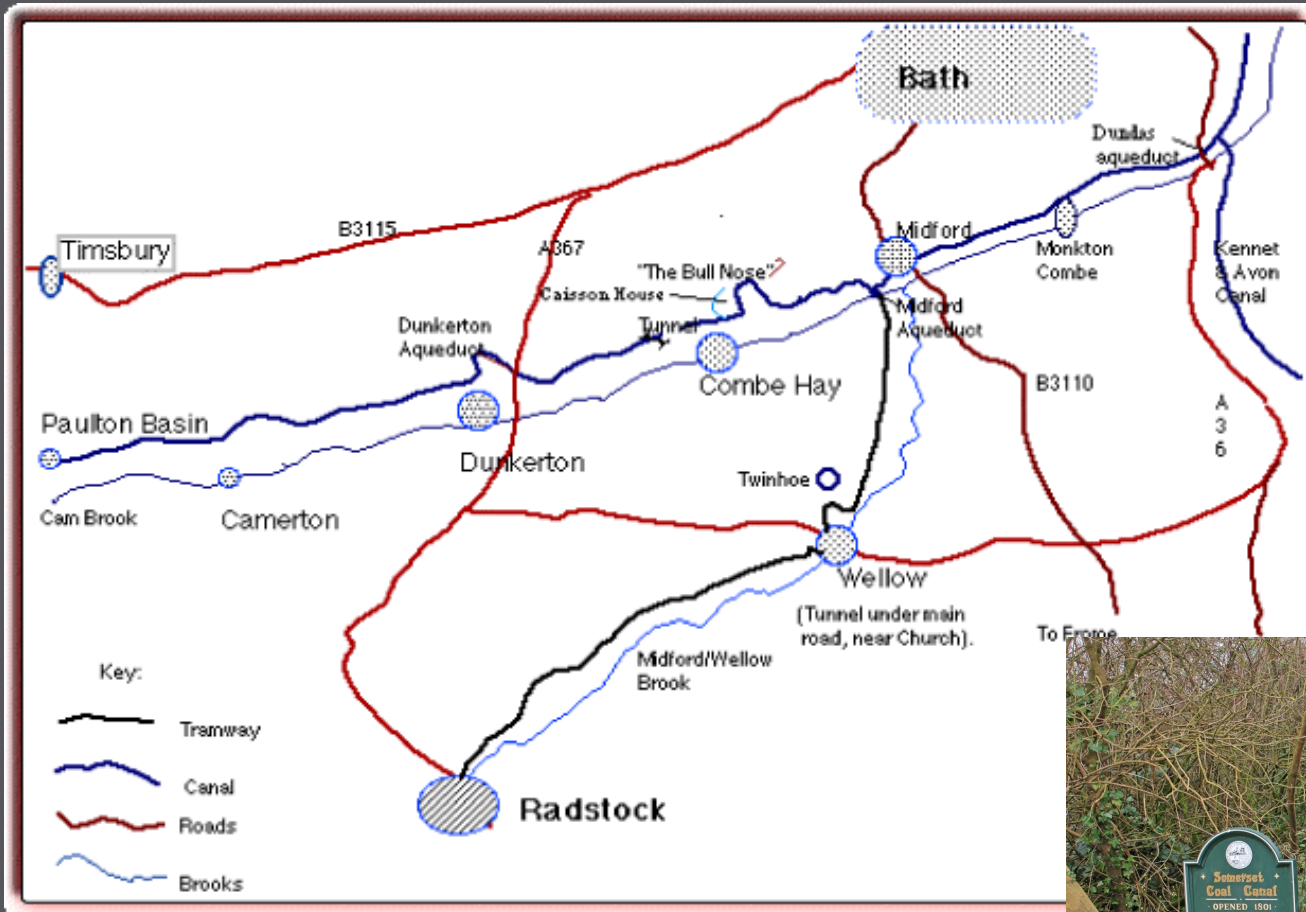


**1797-1875**

# William Smith

- Canal Digger, Mapped England's geology for 20 years
- Somerset Coal Canal important transport for Industrial Revolution in England
- Recognized importance of fossils
- 1815 map in England, 414 subscriptions, 350 copies produced, 120-130 believed still in existence

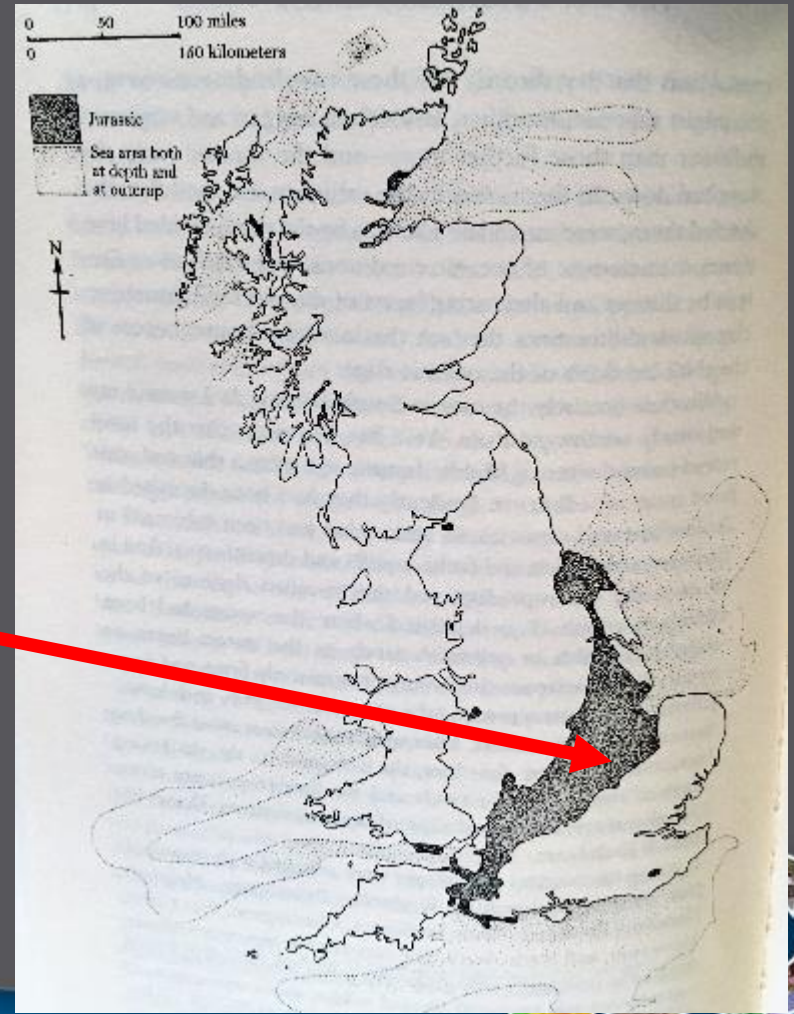
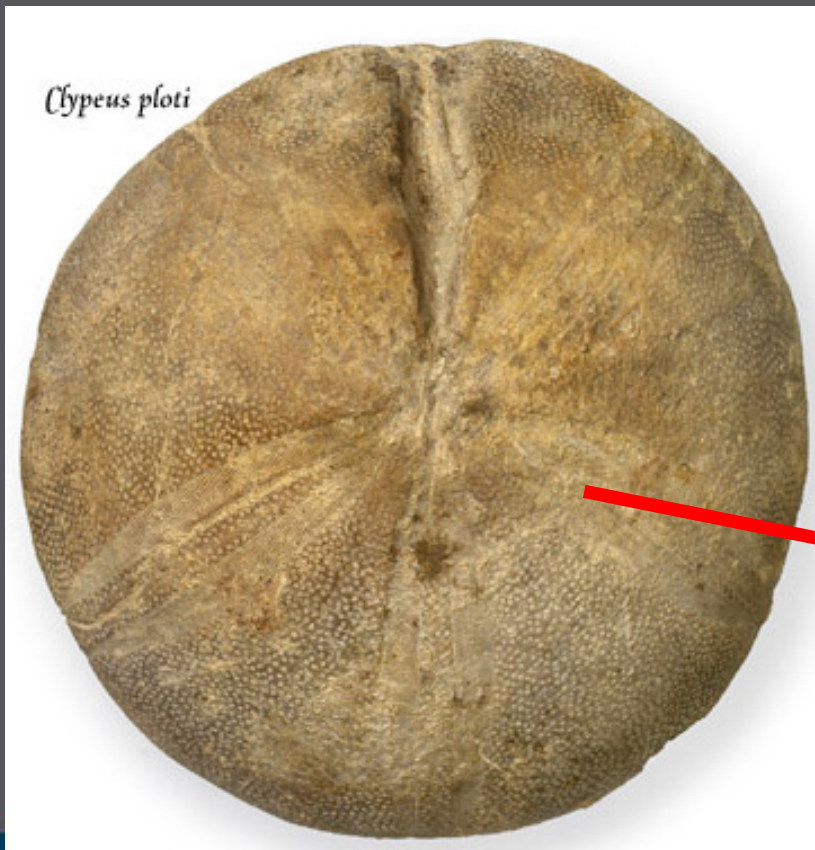
# Somerset Canal



# Fossils, Jurassic Poundstones

## Jurassic Outcrop Belt

### Poundstone (sea urchins)





# The 1815 Smith Map of England



## Highlights

- Map showed color patterns not points
- Shading carried the information
- Allowed for projection of layers or strata into 3 dimensional space



# William Maclure

## Map of Appalachians 1809, 1817

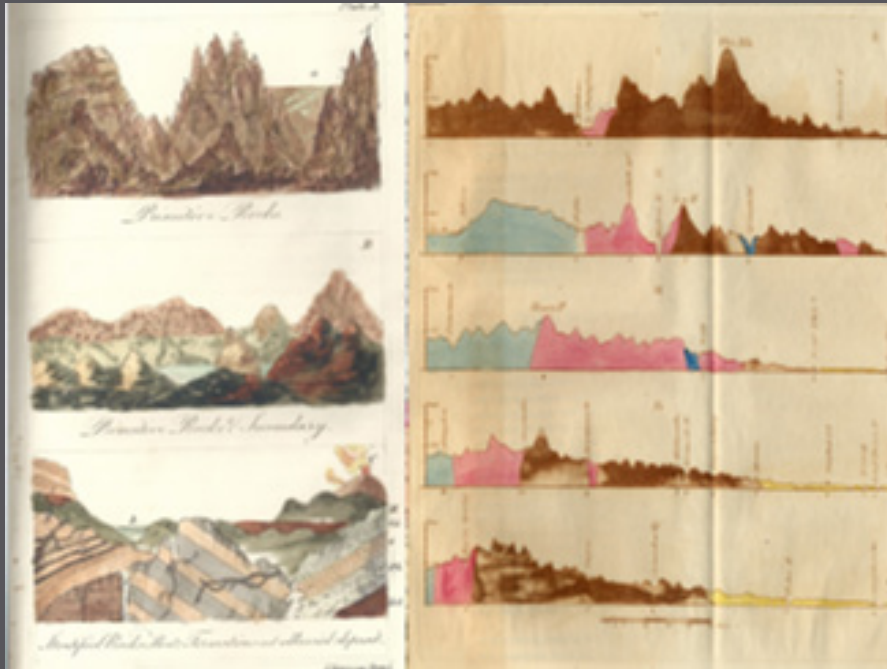


## Wernerian System

- Class I: Primitive (brown) – Crystalline rocks comprising much of the Appalachian Piedmont and Blue Ridge provinces, now known to be Paleozoic and Precambrian.
- Class II: Transitional (red) – Tilted, folded and deformed sedimentary strata that form a narrow band within the Appalachian Mountains, the Valley and Ridge province, now known to be Paleozoic and Triassic.
- Class III: Flötz or Secondary (blue) – Flat-lying sedimentary strata that form all of the Appalachian Plateau and interior lowland west of the plateau to the Mississippi, now known to be Paleozoic.
- Class IV: Alluvial (yellow) – Poorly consolidated to unconsolidated sediment of the Atlantic and Gulf coastal plains, including the Mississippi embayment, now known to be Cretaceous, Tertiary, and Quaternary. By coincidence, yellow is still the standard color on geological maps for Quaternary alluvium.

# An Intermediate Step

## Cross Sections



## William Maclure

- Wm Maclure (1763-1840) made first geologic map of the Eastern US 1809
- Used Wernerian system
- Believed US would remain agricultural society, opposed Erie Canal



# The American Team

**Dewitt Clinton, Governor**



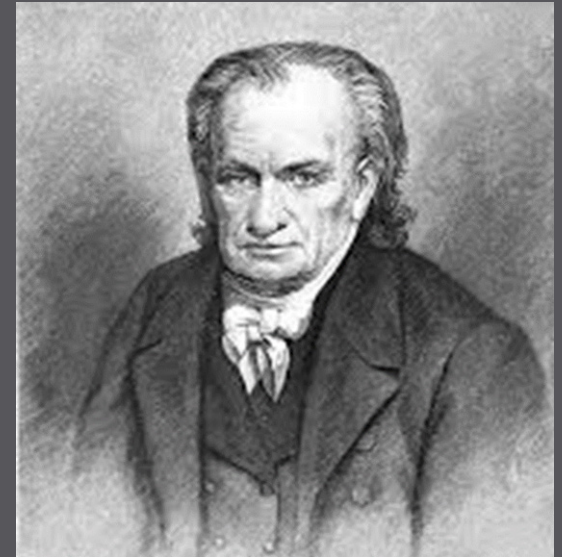
**1769-1828**

**Stephen Van Rensselaer,  
Patron**



**1764-1839**

**Amos Eaton,  
Scientist, Educator**



**1776-1842**

# It starts with geological mapping

- William Smith worked out geology of England based on canal exposures facilitating industrial revolution (Simon Winchester) 1815
- Similar work started in New England after the War of 1812 and mapping into 1820 and beyond
- NY possessed many advantages of geography, plus:
- Collaboration of business men, land owner, government, and science

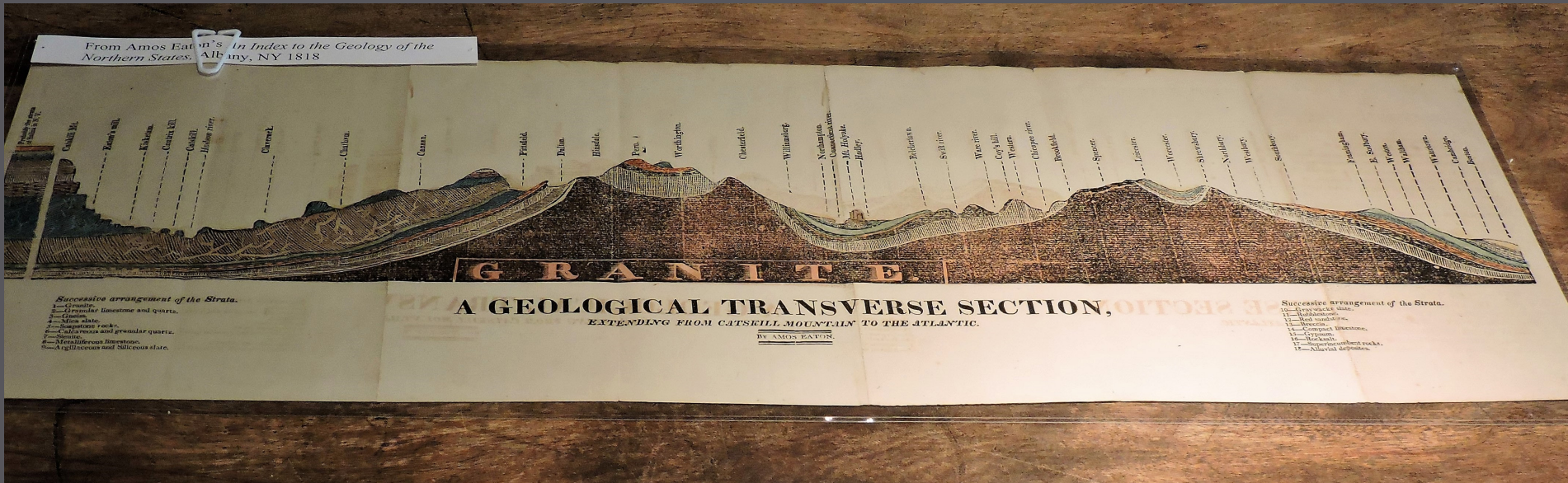
# Amos Eaton highlights

- Eaton career buffeted by extremes of failure and success
- Started out as lawyer, imprisoned for debt (common in those days)
- Taught the jailers son natural science and botany
- Was pardoned for good deeds and fortuitous timing at outset of War of 1812
- Became a lecturer on the circuit

# Amos Eaton teaching

- Encouraged scientific education for men and women
- Pedagogical device: students change roles to act as teachers
- Field work and applied science become
- Founded a school and curriculum at RPI 1824 to create a corps of geologists to map NY and the early US
- Many graduates founded State Geological Surveys

# Eaton's 1818 Traverse from Catskills to Atlantic



500 miles from the Catskill Mountains to the Atlantic Ocean  
 Longest Geologic Transect of its day

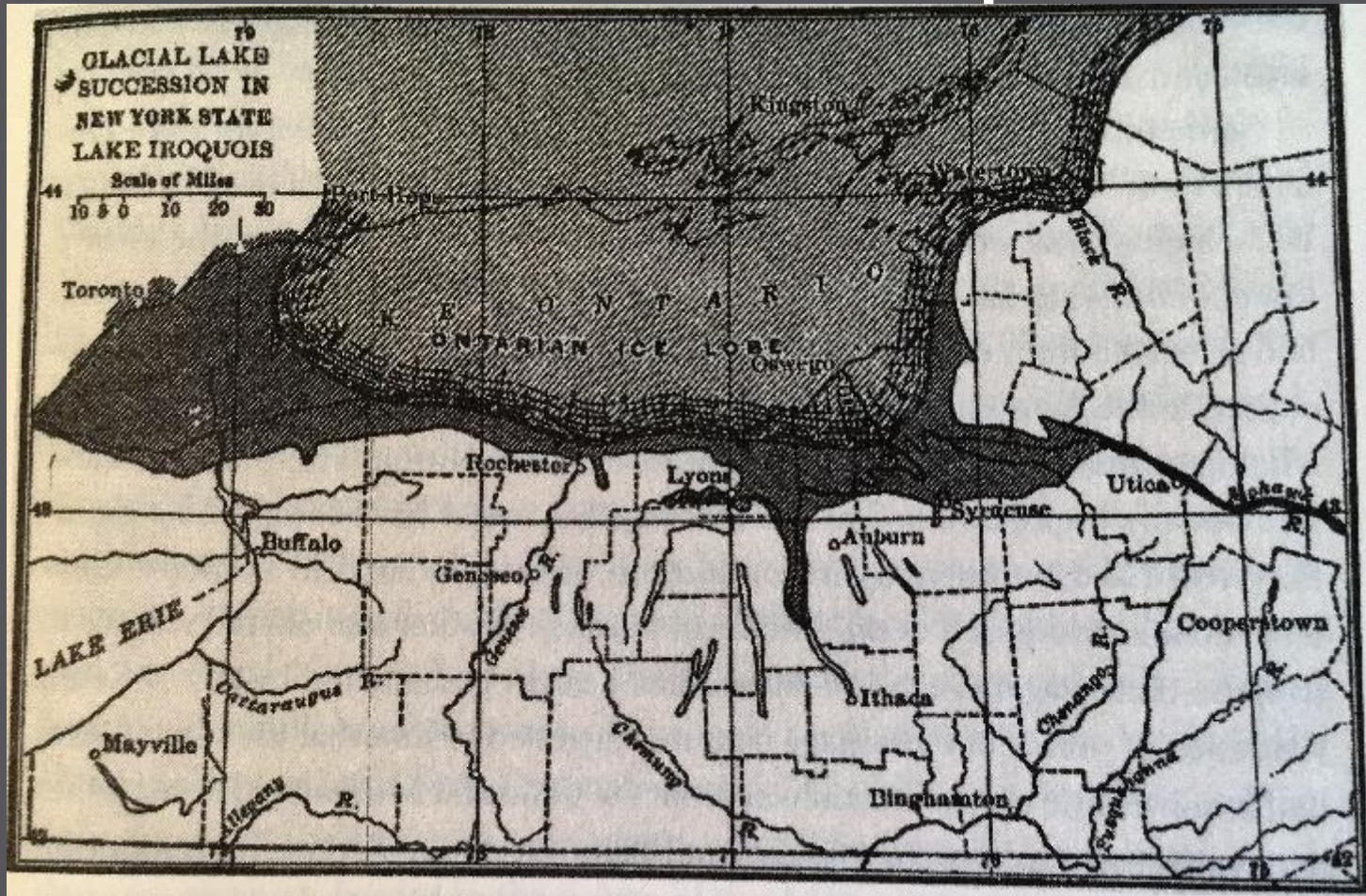


# Geography and the Erie Canal

National Elevation Data Set Shaded Relief of New York



# Glacial Lake Iroquois



Isaiah Bowman, Yale and President of John Hopkins, Noted: Ridge road as Lake Ontario's Former southern shoreline and the Mohawk River would have provided drainage to the Atlantic Ocean



# Views of the Helderberg Escarpment



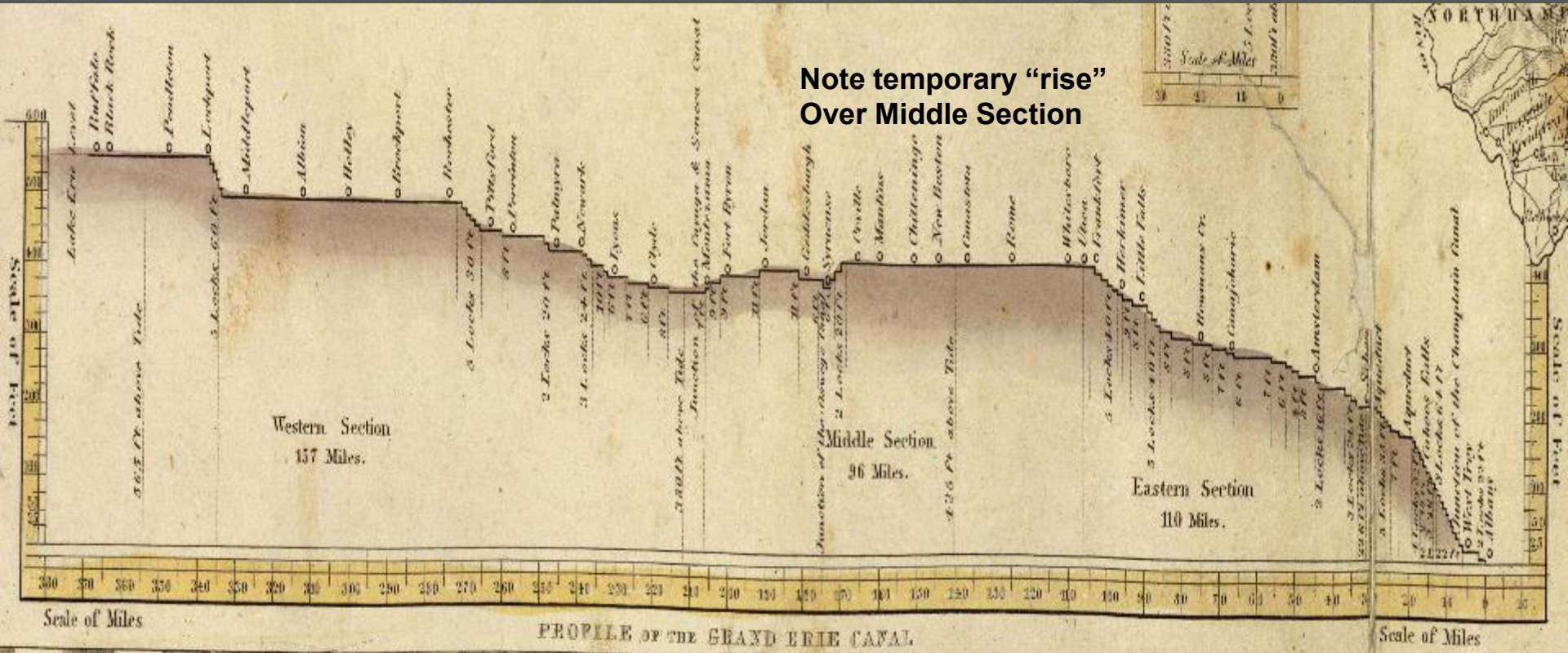
# Map of the Grand Erie Canal



# Profile of the Grand Erie Canal

WEST

EAST



# Erie Canal Motivating Factors

- Key to Uniting the United States
- Settling of the Interior difficult, food land locked, economic drivers
- Political reasons to expand into the interior
- Scientific curiosity, what are the resources of NY and New England?
- Looking for more coal, found salt and construction materials

# The Erie Canal: 1817 to 2017, 200 years

- First proposed in 1780's, re-proposed 1807, delayed by war of 1812, construction begun in 1817
- Also known as “Clinton’s Folly” and “Clinton’s Big Ditch”
- Pathway from Great Lakes to Atlantic Ocean
- Originally 363 miles long with 36 locks
- Maximum height above MSL 571
- 95% Faster and cheaper than barges pulled by animals
- Fostered population surge in W. NY and interior
- Peak year 1855 33,000 commercial shipments took place
- Still open

# Wall in NY State Museum, Albany





# Mohawk Falls



A 4,500-foot-long power canal carries water from the pond in the Mohawk River backed-up by the Cohoes Company Dam to the Lower Gatehouse. There it is directed into five penstocks—large steel pipes that run down the face of the gorge to the powerhouse. Water from each penstock



# Pathway to Mississippi River, Chicago Cross Roads



# Locks Engravings (1830)



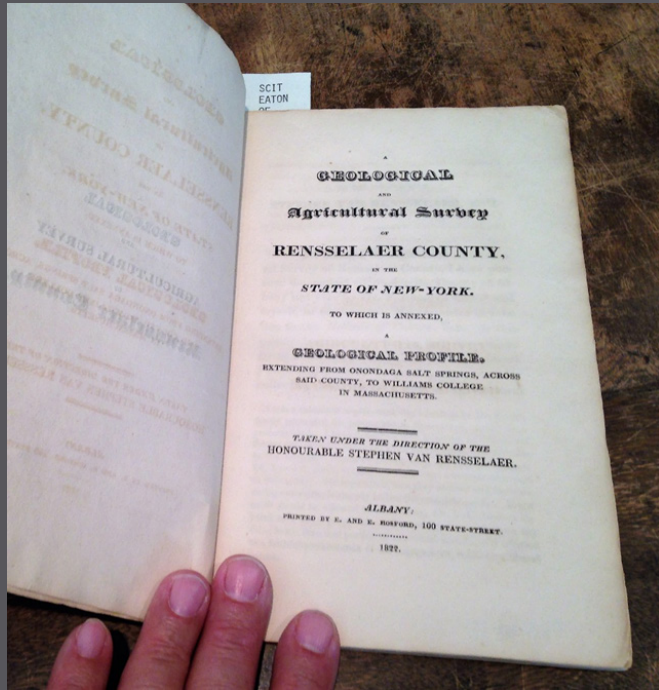
# Gerald and Sue Friedman Historical Geology Library at RPI contains Smith And Eaton Maps



# Field Work, The Hudson Flotilla, 5 trips on the Erie Canal (1822-1824)

- 1) Fall of 1822, Recon Mission, sedimentary “transition” rocks of Werner classification
- 2) Spring 1823, “broad alluvion”, glacial drift
- 3) Summer 1823, mineral search for salt (food preservative), gypsum (fertilizer) & coal (fuel)
- 4) Winter 1823, fill in data points away from canal, rock sets for patrons,
- 5) Spring 1824, Discovery of sunken forests (due to glaciation), teaching along the way

# Eaton's Journals, Map and Cross Section



# Eaton's Journals, Map and Cross Section

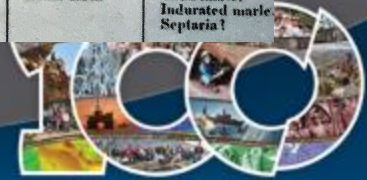


# Rock types and fossils

CASE OF SPECIMENS. CLASSES 2 & 1.	GENERAL STRATA and SUBDIVISIONS.	VARIETIES.	IMBEDDED and DISSEMINATED.
	SECOND GRAY-WACKE. B. Rubble. A. Compact.	Red sandy, (old red sand!) Blue-slate. Grind-stone.	Manganese. Anthracite.
	METALLIFEROUS LIMEROCK. B. Shaly. A. Compact.	Birdseye marble.	
	CALCIFEROUS SANDROCK. B. Geodiferous. A. Compact.	Quartzose. Sparry. Oolitic.	Semi-opal. Anthracite. Barytes. Concentric concretions.
	SPARRY LIMEROCK. B. Staly. A. Compact.	Checked rock.	Chlorite. Calc spar.
	FIRST GRAY-WACKE. B. Rubble. A. Compact.	Chloritic.	Milky quartz. Calc spar. Anthracite.
	ARGILLITE. B. Wacke Slate. A. Clay Slate.	Chloritic. Glazed. Roof-slate. Red. Purple.	Flinty slate. Anthracite. Striated quartz. Milky quartz. Chlorite.
	GRANULAR LIMEROCK. B. Sandy. A. Compact.	Verd-antique. Dolomite. Statuary marble.	Tremolite. Serpentine. Chromate of iron
	GRANULAR QUARTZ. B. Sandy. A. Compact.	Ferruginous. Yellowish. Translucent.	Manganese. Hematite.
	TALOSE SLATE.		Octahedral crystals of iron ore. Chlorite.
	B. Fissile. A. Compact.	Chloritic.	
	HORNLENDE ROCK. B. Staly. A. Granitic.	Greenstone. Gneissoid. Porphyritic. Sienitic.	Granite. Actynolite. Augite.
	MICA-SLATE. B. Fissile. A. Compact.		Staurolite. Sappare. Garnet.
	GRANITE. B. Staly. (gneiss) A. Crystalline.	Sandy. Porphyritic. Graphitic.	Shml. Plumbago. Steatite. Diallage.

CASE OF SPECIMENS. CLASSES 4 & 3.	GENERAL STRATA and SUBDIVISIONS.	VARIETIES.	IMBEDDED and DISSEMINATED.
	BASALT. B. Greenstone trap (columnar.) A. Amygdaloid, (cellular.)		Amethyst. Calcedony. Prelinite. Zeolite. Opal.
	THIRD GRAY-WACKE. B. Pyritiferous grit. A. Pyritiferous slate.	Conglomerate, (breccia.) Calcareous grit. Red sandstone, (old red sandstone) Red-wacke. Argillaceous.	Grindstone. Homstone! Honeslate. Bituminous shale and coal. Fibrous barytes.
	CORNIFEROUS LIMEROCK. B. Shelly. A. Compact.		Hornstone.
	GNEISSIFEROUS LIMEROCK. B. Shaly. A. Sienitic.	Forfid.	Snow-gypsum. Strontian. Zinc. Fluor spar.
	LIAS. B. Calciferous grit. A. Calciferous Slate.	Shell grit. Argillaceous. Conchoidal.	Shell limestone. Vermicular. Water cement. Gypsum.
	FERRIFEROUS ROCK. B. Sandy. A. Staly.	Conglomerate. Green. Blue.	Argillaceous iron ore, (reddle.)
	SALIFEROUS ROCK. B. Sandy. A. Marble-slate.	Conglomerate. Grey-band. Red-sandy. Grey slate. Red slate.	Salt, or salt springs.
	MILLSTONE GRIT. B. Conglomerate. A. Sandy.		Coal

CASE OF SPECIMENS. CLASSES 6 & 5.	GENERAL DEPOSITS and SUBDIVISIONS.	VARIETIES.	IMBEDDED AND DISSEMINATED SUBSTANCES.
	SUPERFICIAL ALLUVION. B. Granulated, (from gray-wacke.) A. Clay-loam, (from argillite.)		Various boulders. Pebbles.
	STRATIFIED ALLUVION. C. Lias. B. Ferriferous. A. Saliferous.		Gypsum. Shell limestone. Reddle.
	POST-DILUVION. B. Sediment. A. Pebbles, (in the rocky bed of a river.)		Various boulders. Trees and herbs. Fish bones and shells. Works of art.
	ULTIMATE DILUVION, (on crag in old forests.)	Yellowish grey. Greyish yellow.	
	DILUVION, (in an antidiluvial trough.)	Quicksand. Gravel. Vegetable mould.	Boulders. Trees and leaves. Bones and shells. No works of art.
	ANTIDILUVION. C. Bagshot sand and crag. B. Marley clay.		Quicksand. Yellow sand. Hardpan. Brick earth
	A. Plastic clay.		Pudding-stone. Bulurstone. Bog ore. Shell-marle. Indurated marle. Septaria?

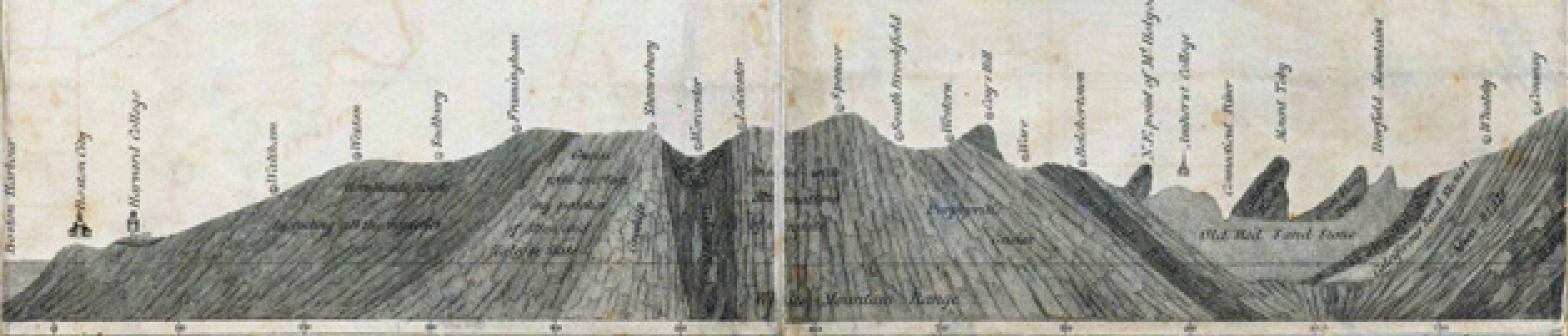




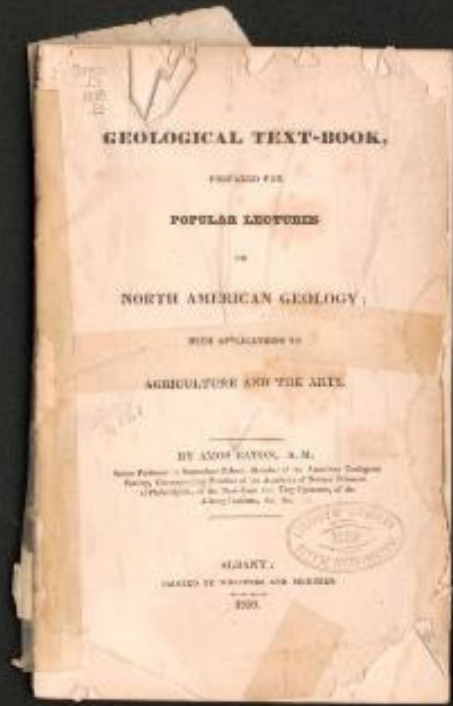
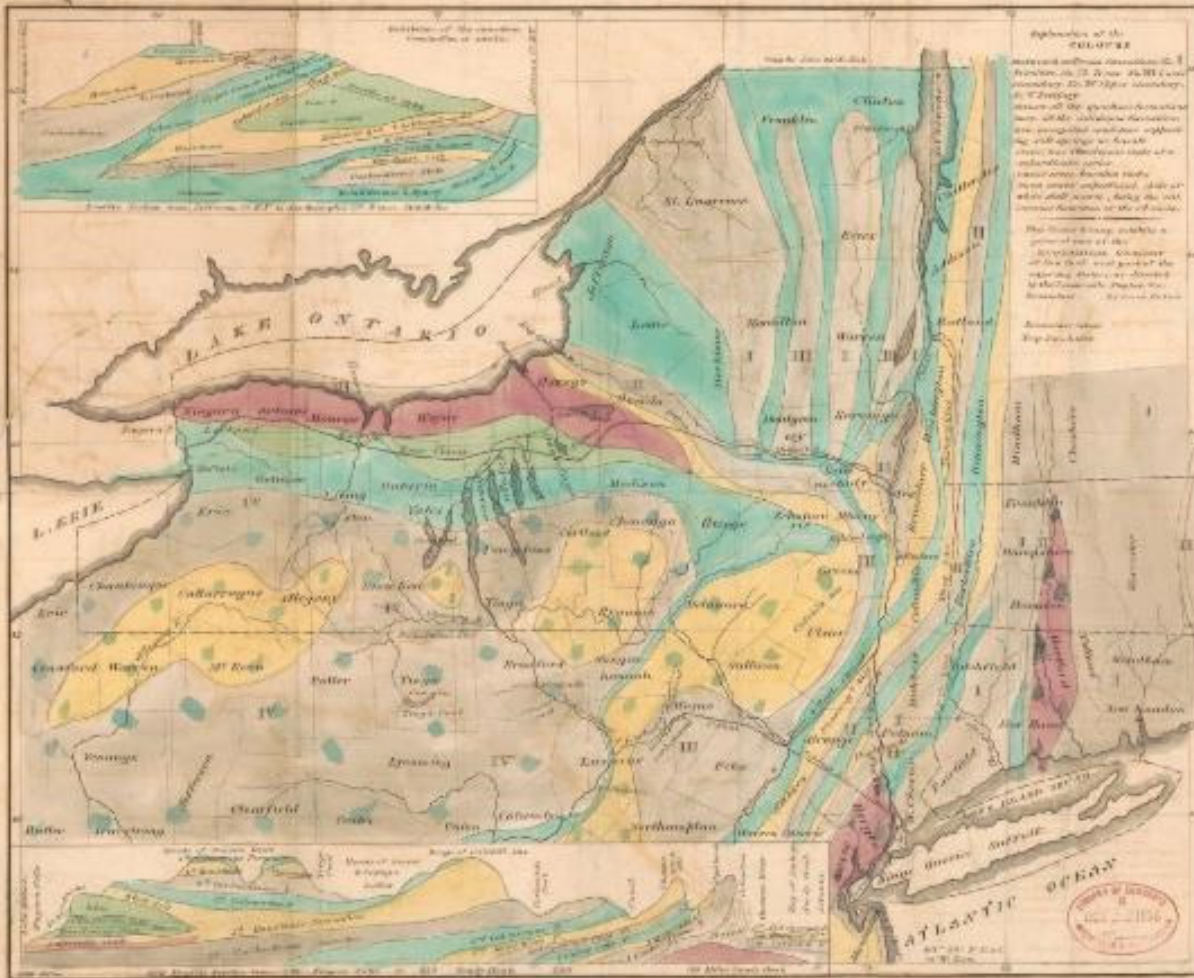
# GEOLOGICAL PROFILE EXTENDING FROM THE Atlantic to Lake Erie

Running near the 1.3° N. L. and embracing 9 degrees of  
Longitude. Taken 1822 & 3, under the direction of the  
Hon. STEPHEN VAN RENSSELAER, By James G. Kent.

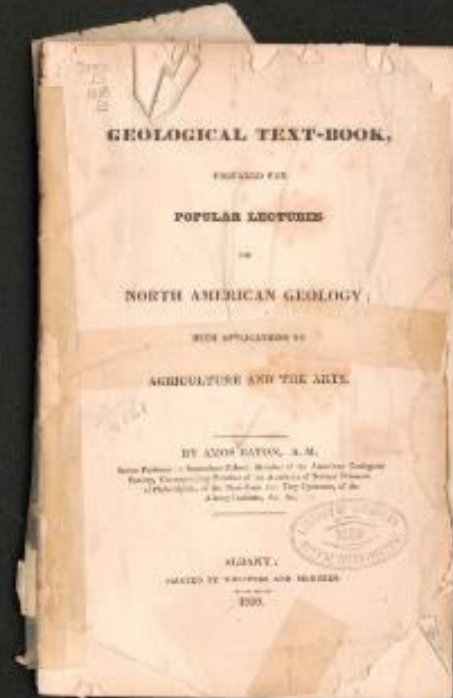
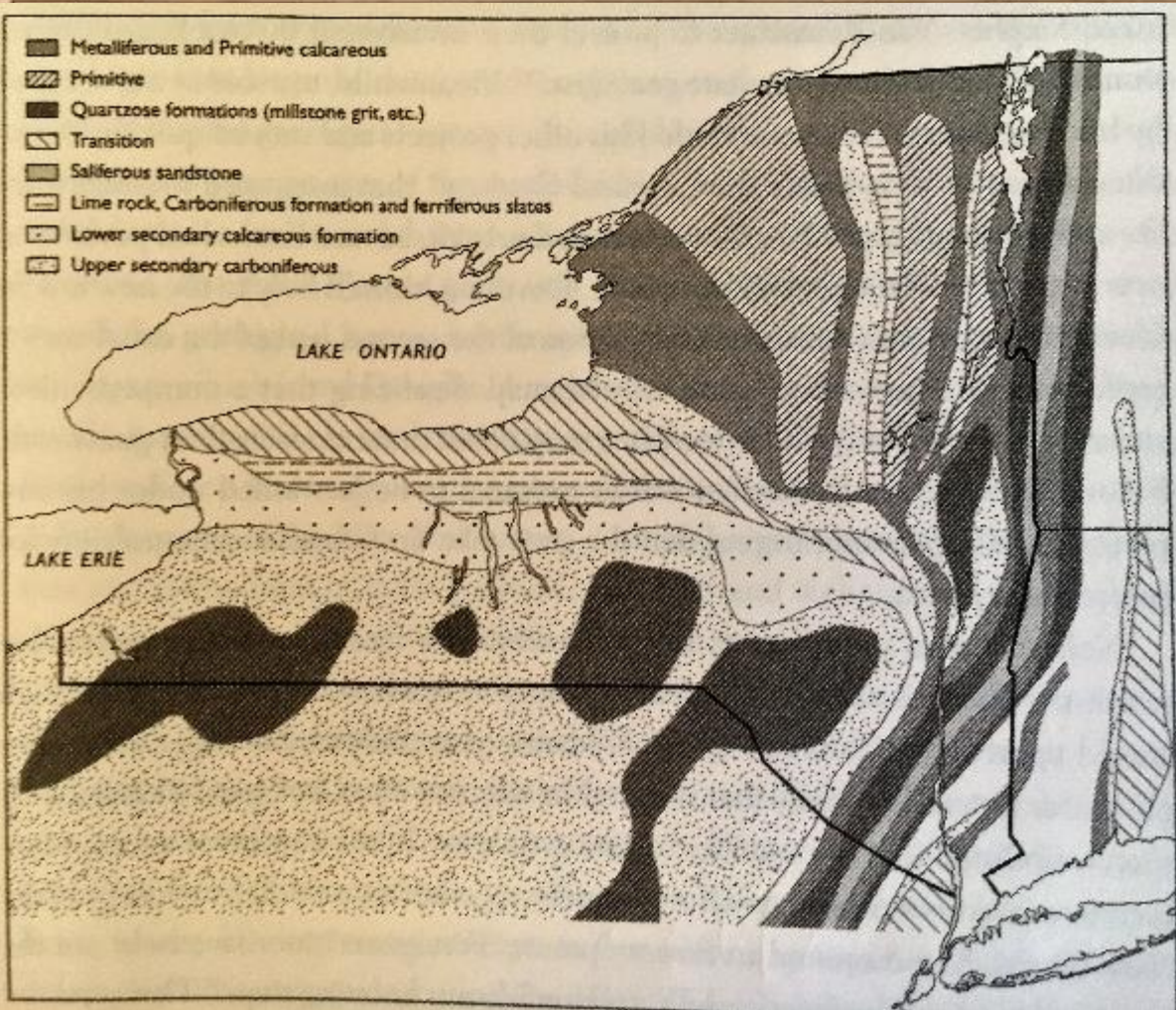
Revised by Beekel, Clark & Sillig



# The NY MAP, 1830



# The NY MAP, Explained



# REGIONAL RANKING 1: NEW YORK

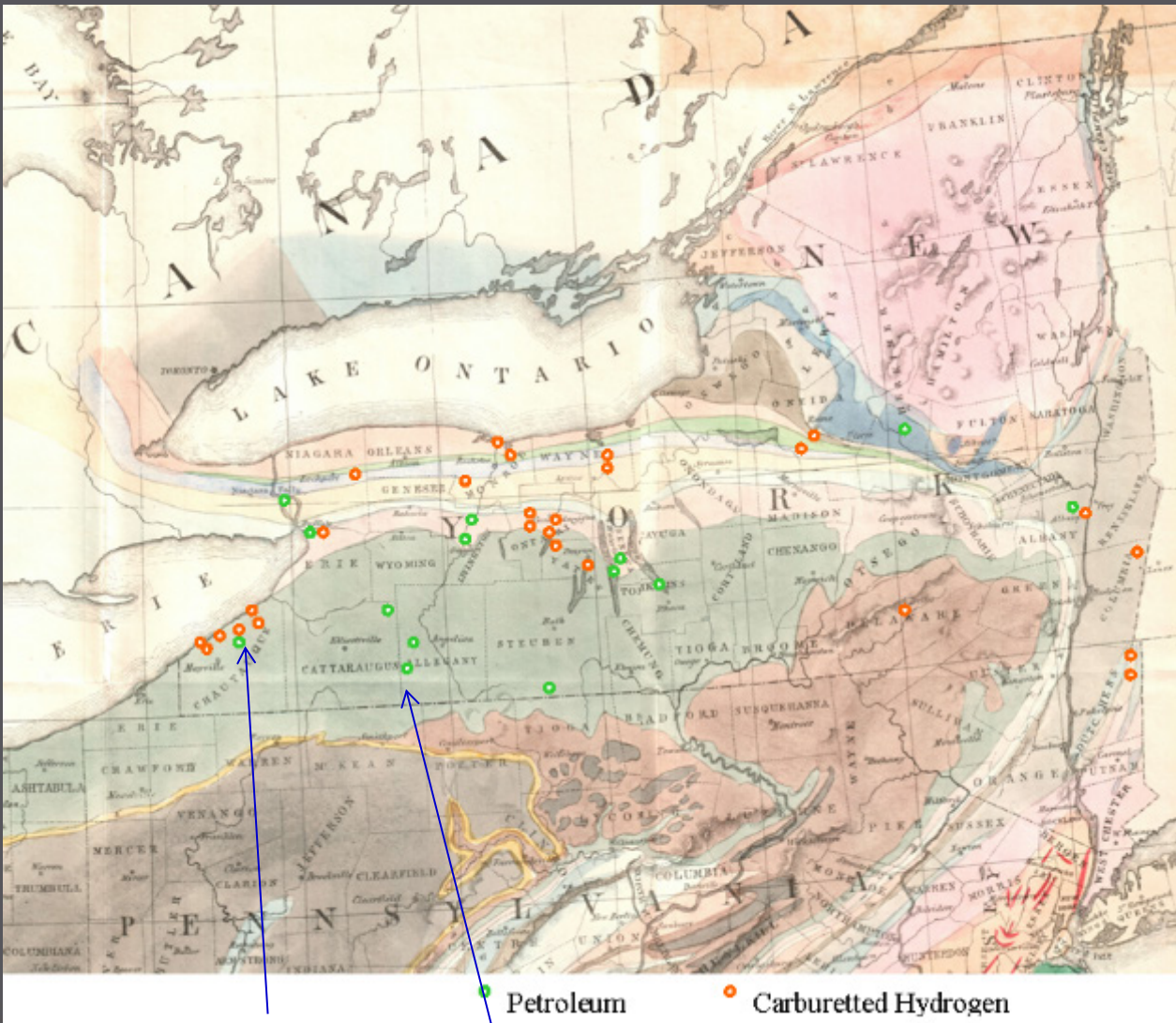
High profile oil seep at **Cuba**, gas production at **Fredonia**

NY Geological Survey 1836-1843: >200 references to oil and gas

Oil reported in 8 counties

Carburetted hydrogen reported in 14 counties

Good market access

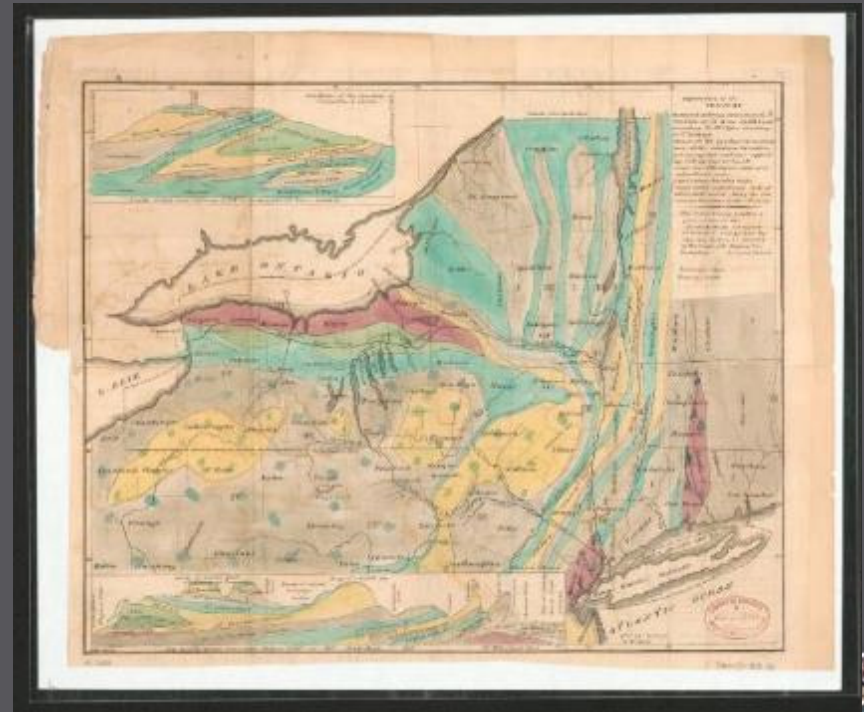


**Fredonia Cuba**

Thanks to Ray Sorenson



# Map Comparison (roughly to scale)



# Links to England

- 1818-1836 Eatonian Era in the US
- Several visits by Charles Lyell to US
- Lyell and Eaton visit in 1841 (1 year before Eaton's death)

# Educational Legacy link to today

- RPI founded in 1824
- First civilian Engineering education outside of West Point
- Applied Education in contrast academic or “pure” science
- Defines American educational values over European
- Emphasis on laboratory and Field exercises
- Pedagogical approach: students teach

# Amos Eaton and the Geological Imperative

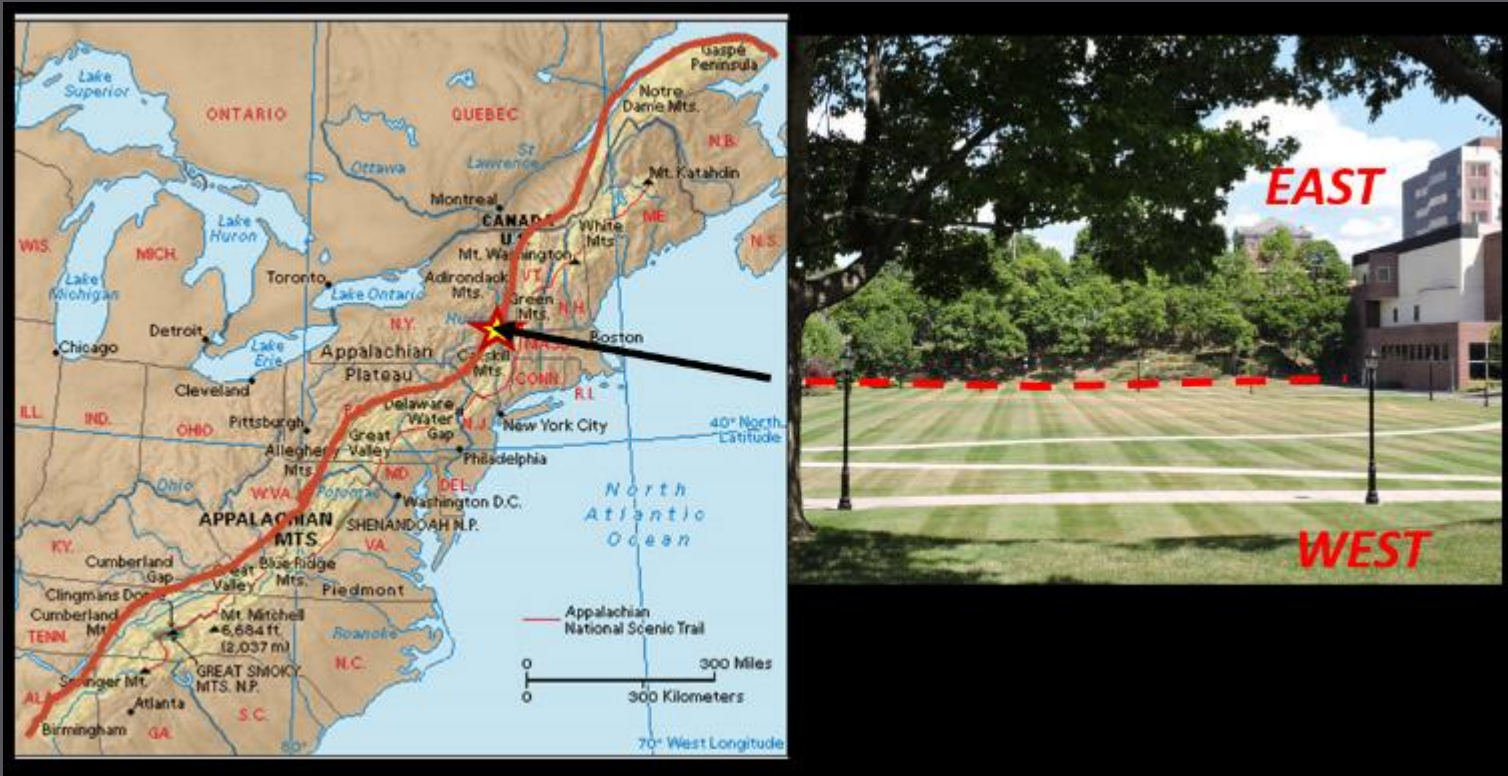
- Geology was the science that enabled New Yorkers to cultivate power through the knowledge of place
- New York's example: science was a key to effective natural resource exploitation
- This created a burgeoning of social investment in scientific authority

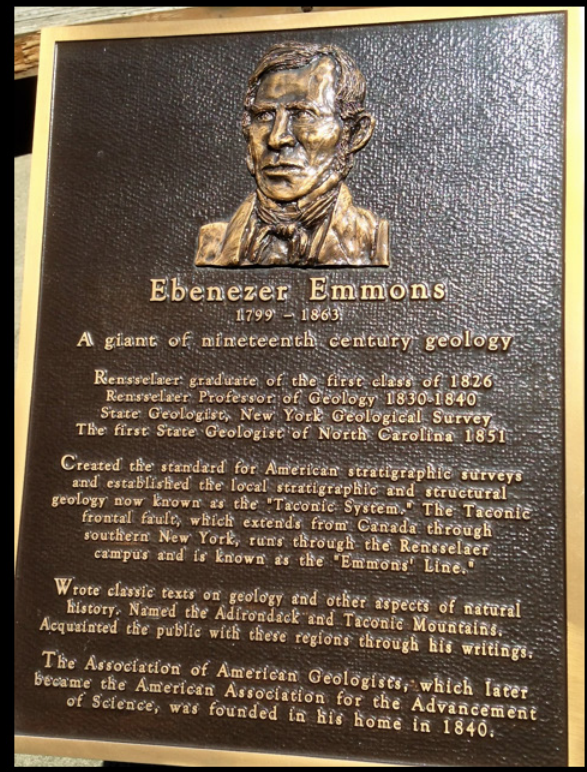


## Rensselaer Grads leadership roles at least 11 State Geological Surveys

- Michigan, Douglass Houghton
- N. Carolina, Ebenezer Emmons
- New Jersey
- Virginia
- New York
- Pennsylvania
- Ohio
- Delaware
- S. Carolina
- Wisconsin
- Iowa

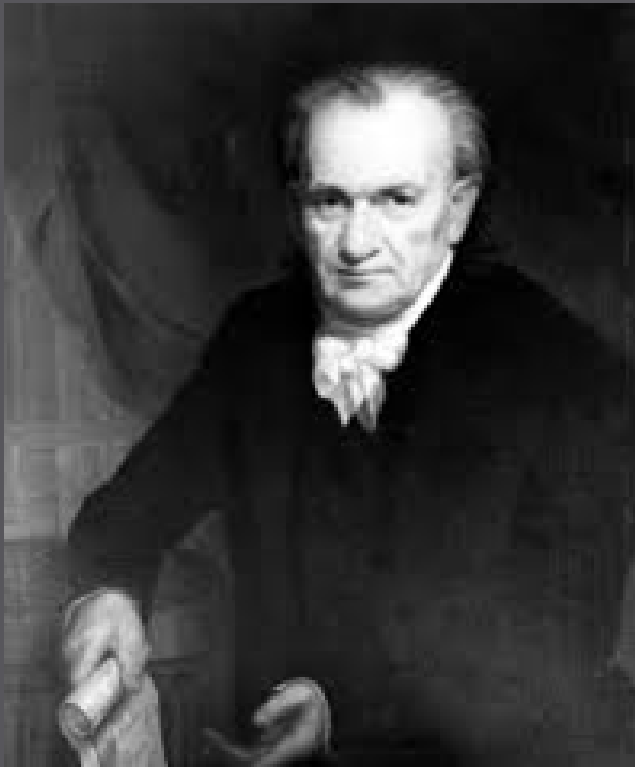
# Emmon's or Logan's Line





# Kindred RPI Geology Professors

**Amos Eaton, 1776-1842**



**Gerald M. Friedman, 1921-2011**



# “Keeper of the Flame”

## Gerry Receives the AAPG Sidney Powers Medal, Houston 2000



## Remembering Gerry

### MEMORIAL



#### GERALD M. "GERRY" FRIEDMAN 1921–2011

By Charles A. Sternbach  
Houston, Texas

Gerald M. "Gerry" Friedman passed away in his sleep on November 29, 2011 at the age of 90 years old in New York City. He was an AAPG member since 1958.

#### AAPG

Receiving the Sidney Powers Medal in 2000, Gerry was a consummate geologist, researcher, and professor. He authored more than 537 papers and 19 books. He was active in all three AAPG divisions and served as AAPG vice president in 1984. In addition to being a Powers medalist, he was honored by AAPG with Honorary Membership, Distinguished Educator Award and Distinguished Service Award. He was a Trustee Associate

its application to oil exploration. Through his teaching, writing, and scientific analysis, Gerry was one of the greats in the field of applied sedimentology, which he helped create. He was among the first to recognize the predictive value of sedimentology as key to the discovery of many overlooked stratigraphic traps.

#### Publications

Gerry wrote geologic papers that shaped the thinking of generations of geoscientists. His textbook *Principles of Sedimentology*, co-authored in 1978 with John E. Sanders of Columbia University, sold almost 30,000 copies. The two authors also made available thousands of free copies to faculty; supported a private printing in China, Korea, Taiwan, and Indonesia; and supported a translation into Chinese. *Principles of Sedimentary Deposits: Stratigraphy and Sedimentology*, co-authored with John E. Sanders and D. E. Kopaska Merkel in 1992, built on the scope and success of the first textbook and was widely adopted for undergraduate and graduate students.

#### Journals

Gerry founded three geologic journals of international stature: *Carbonates and Evaporites*; *Earth Sciences History*, and *North Eastern Geology and Environmental Sciences*. While editor of the *Journal of Sedimentary Petrology* (now *Journal of Sedimentary Research*), he had the task of guiding that journal through the boom of the 1960s and 1970s.

bestowed on him. In addition to AAPG awards cited above, these include the SEPM (Society for Sedimentary Geology) Twenhofel Award; AAPG's John T. Galey (Eastern Section) award; New York's James Hall Medal; American Geological Institute's 2005 Legendary Geoscientist Award; Hollis D. Hedberg Award in Energy from the Institute for the Study of Earth and Man at Southern Methodist University; and citations as Honorary Member in AAPG, SEPM, IAS (International Association of Sedimentologists), the Geological Society of London, and Sigma Gamma Epsilon. Gerry also received an Honorary Doctorate in geology from Heidelberg University, only the third individual to do so in its 600-year history.

#### Early Life

Gerry was born in 1921, in a quiet section of Berlin. He moved to London in June 1938. He always felt that one of his greatest accomplishments was escaping WWII Germany. His schooling at Cambridge and then the University of London was especially hard because he had to educate himself to pass the entrance exams in English and Physics, which he did with high honors, after working long hours as a baker and wartime firefighter. On graduation, he worked for J. Lyons and Company briefly, and one of his co-workers was Margaret Thatcher. Gerry then immigrated to the United States. In 1948, he



# Remembrances



# Oaklawn Cemetery, Troy NY



# Sidney Powers





# Acknowledgements

- Hugh Torrens, William Smith Historian
- Simon Winchester, “The Map that Changed the World, 2001”, popularizing author
- Peter Wigley, William Smith Historian
- David I. Spanagel WPI Professor, “De Witt Clinton and Amos Eaton” 2014
- RPI Librarian/Historian