THE HISTORY OF MUDSTONE INVESTIGATIONS

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Examples of "Mudstone Events"

- Articles in professional journals and theses
- New methods of observation and measurement
- " New territory" events — exploration of the deep sea, the study of modern muds of a large river system both on and offshore, systematic study of selected modern muddy environments, etc.
- "Communication events" — books and the formation of speciality societies, both of which collect, organize and disperse new ideas and data

[15]The strata here enumerated are given in the Glossary of *De Re Metallica* as follows :—

Corium terrae	*Die erd oder leim.*
Saxum rubrum	*Rot gebirge.*
Alterum item rubrum	*Roterkle.*
Argilla cinerea	*Thone.*
Tertium saxum	*Gerhulle.*
Cineris vena	*Asche.*
Quartum saxum	*Gniest.*
Quintum saxum	*Schwehlen.*
Sextum saxum	*Oberrauchstein.*
Septimum saxum	*Zechstein.*
Octavum saxum	*Underrauchstein.*
Nonum saxum	*Blitterstein.*
Decimum saxum	*Oberschuelen.*
Undecimum saxum	*Mittelstein.*
Duodecimum saxum	*Underschuelen.*
Decimumtertium saxum	*Dach.*
Decimumquartum saxum	*Norweg.*
Decimumquintum saxum	*Lotwerg.*
Decimumsextum saxum	*Kamme.*
Lapis aerosus fissilis	*Schifer*

The description is no doubt that of the Mannsfeld cupriferous slates. It is of some additional interest as the first attempt at stratigraphic distinctions, although this must not be taken too literally, for we have rendered the different numbered "*saxum*" in this connection as "stratum." The German terms given by Agricola above, can many of them be identified in the miners' terms to-day for the various strata at Mannsfeld. Over the *kupferschiefer* the names to-day are *kammschale*, *dach*, *faule*, *zechstein*, *rauchwacke*, *rauchstein*, *asche*. The relative thickness of these beds is much the same as given by Agricola. The stringers in the 8th stratum of stone, which fuse in the fire of the second order, were possibly calcite. The *rauchstein* of the modern section is distinguished by stringers of calcite, which give it at times a brecciated appearance.

Hoover & Hoover (1950, p. 127)

SHALE.

A tolerable hard and black Subſtance, lying moſt commonly in ſome Places next to the Lime-Rock, moſt of it will cut pritty well, riſing in thin Pieces; the Joynts in it are of a red Colour, or gankey, when it is ſunk ſome ſpace into it is mixt with Binds, and when it is drawn up to the Day, it melts and crumbles into ſmall, and into much leſſer Pieces; * it is ſubject to Water, Veins will ſometimes put up into it, and bear Ore, otherwiſe it ſeldome fails in any conſiderable Vein, but there will breath up a Spar leading in the forme of a Ribb, and probably Smuts of Ore in it; this Shale ſeldome requires any Timber to ſupport it, it is very ſtrong and Sulpherous Work, and apt to breed the Ground-Damp, without a good Wind to throw it out.

THE

MINERS DICTIONARY.

By *WILLIAM HOOSON*,
A DERBYSHIRE *Miner.*

Printed for the AUTHOR, and T. PAYNE,
Bookſeller in *Wrexham.*
MDCCXLVII.

What questions can be asked of a timeline?

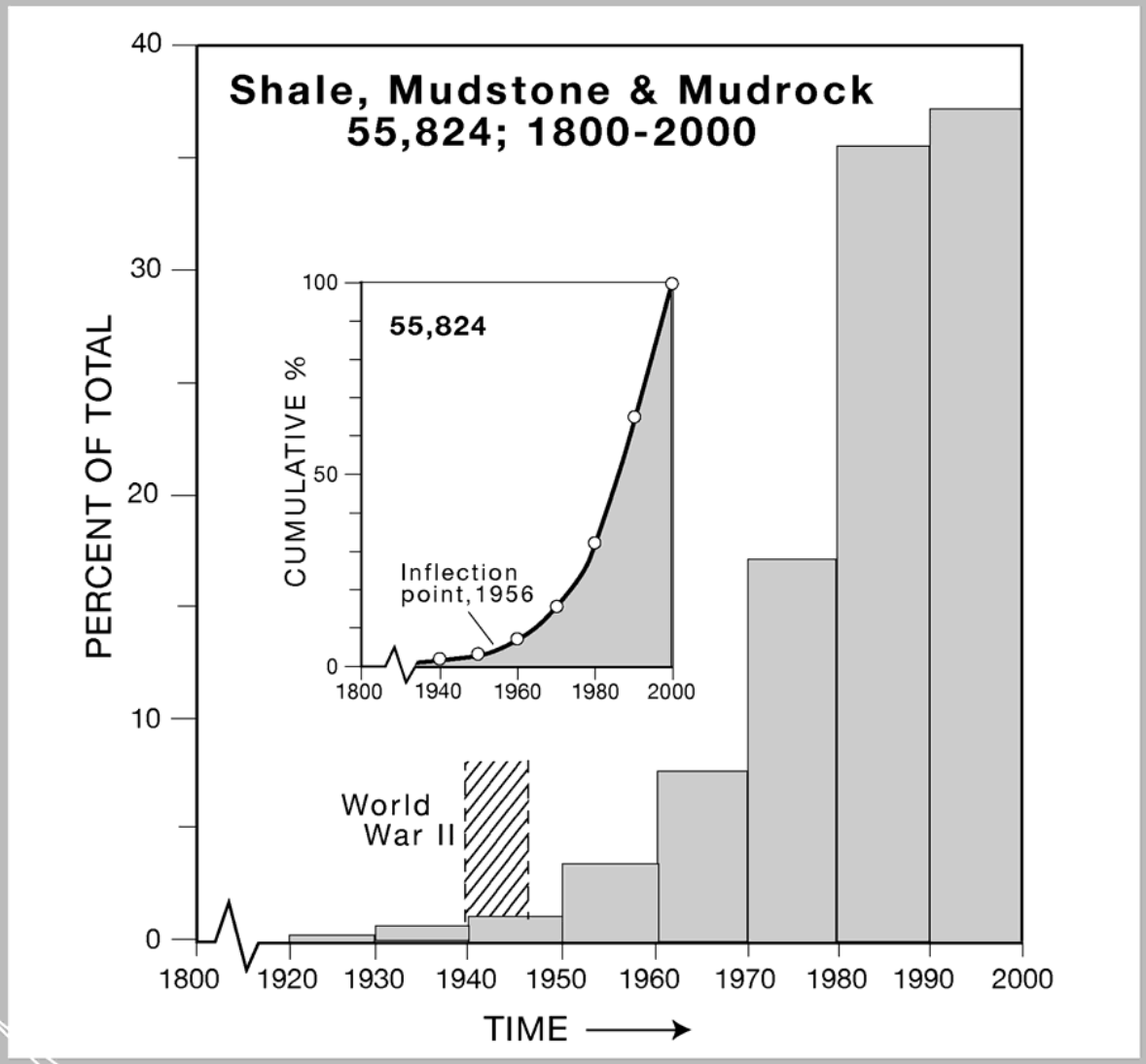
Many, many..... Is the rate of change of activity dependent on world events? How are mudstone advances related to discoveries in other fields? Do concepts and instruments develop at the same rate? What is their relative importance? Was there ever a Golden Age in the study of mudstones? Can we explain this? How would our mudstone timeline compare to ones for sandstones and carbonates or ones in chemistry or physics?

Developmental Stages

Beginnings, pre-1921: Slow, sporadic growth powered by outcrop study supplimneted by wet chemistry, some microscopic observation, and rare studies of modern muds. About two events per decade. Except for paleontology, little attention to shales

Golden Age, 1922-1939: After x-ray observations began in 1922, other methods from physics and chemistry quickly followed and the range of observations expanded many fold (seismic and downhole logging, crystalline structure of clay minerals and organic geochemistry). About nine events per decade

Modern Times, Post War World II, 1947-2008: Modern times saw the standardization of clay mineral techniques, isotopic studies, more studies of modern muds, many more of onshore mudstones, deep sea drilling, sequence stratigraphy and observations from the ängstrom to basin scale. Eight to nine events per decade. Much attention to fine-grained sediments and rocks



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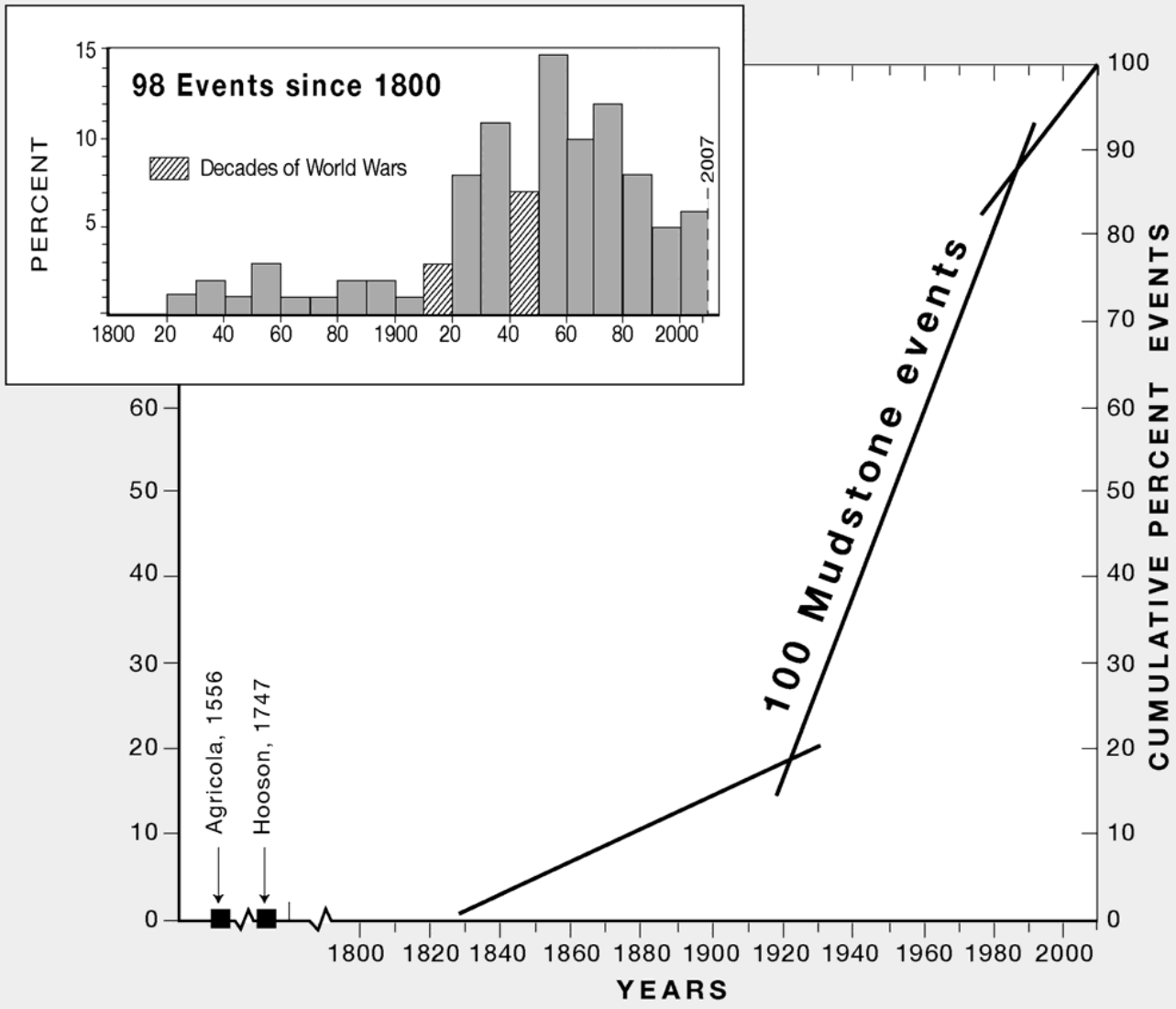

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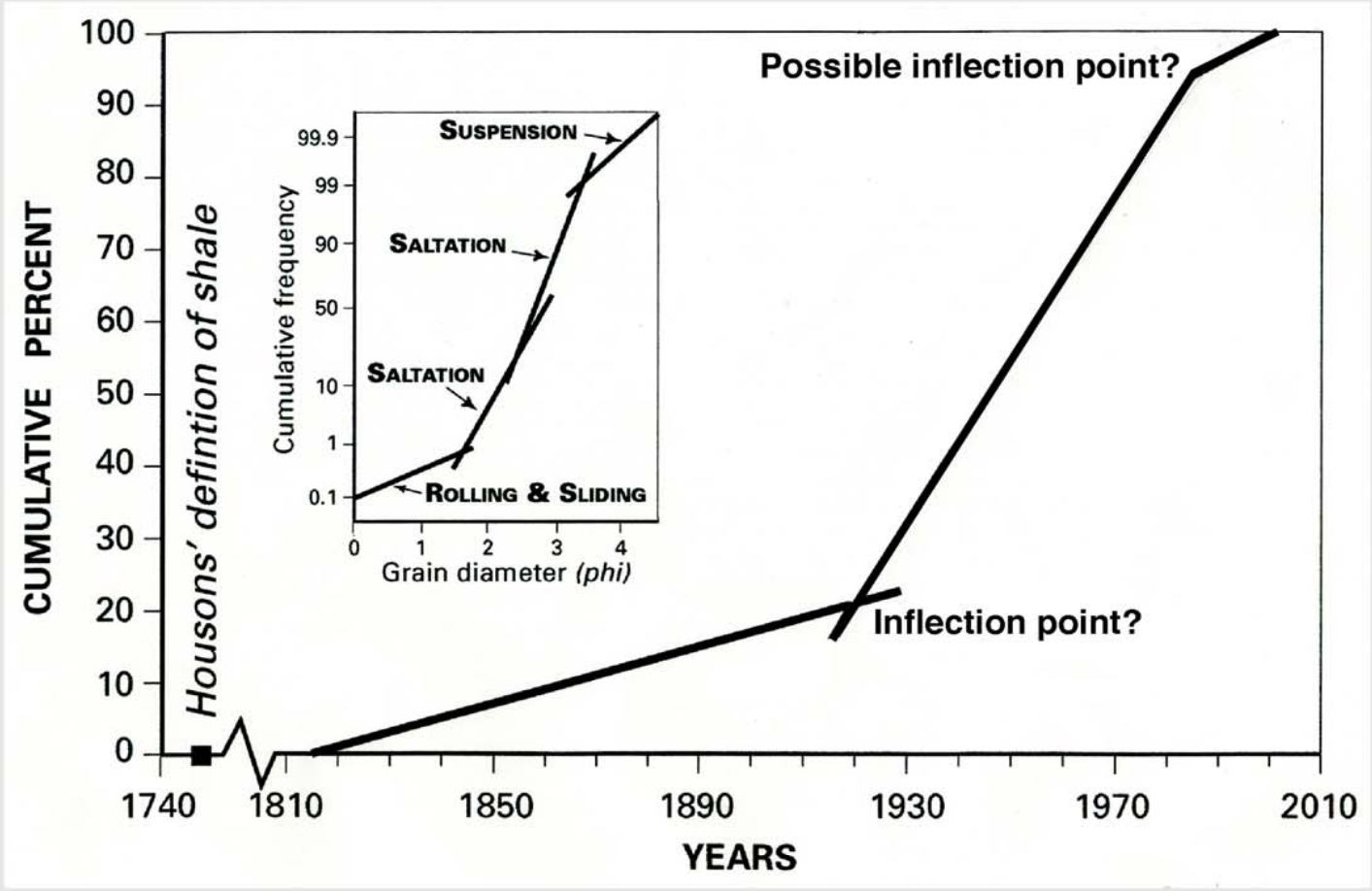

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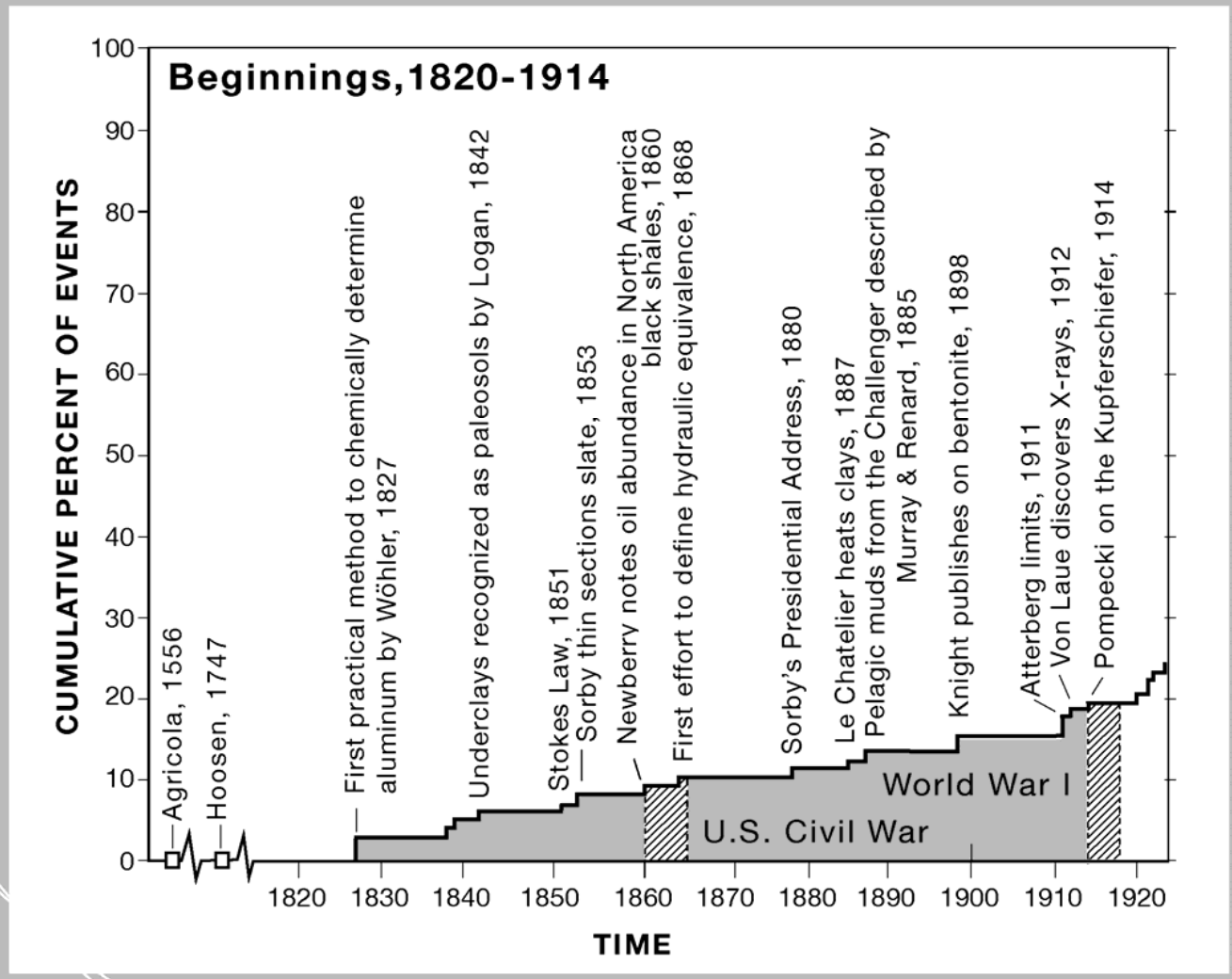

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On the Origin of Slaty Cleavage

BY **HENRY CLIFTON SORBY, F.G.S**

EDINBURGH NEW PHILOSOPHICAL JOURNAL,
V. 4, P. 137-148 (1853)

1826-1880

ON THE EFFECT OF THE INTERNAL FRICTION OF FLUIDS ON MOTION OF PENDULUMS

BY **G. G. STOKES**

TRANSACTIONS OF THE CAMBRIDGE PHILOSOPHICAL SOCIETY,
V. 9, P. 25-106 , (1856)

1819-1903

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Ueber einer neuen Apparat für Schlammanalysen

BY **E. SCHONE**

Zeitschrift für Analytische Chemie
V. 7, P. 29-47 (1868)

De l'action de la chaleur sur les argiles

PAR **M. H. LE CHATELIER**

BULL. SOC. FRANCE MINERALOGIE,
V.10, P. 204-210 (1887)

1850-1936

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XIV.

Das Meer des Kupferschiefers

von **J. F. Pompecki**

Branca-Festschrift, Verlag Gebruden Born Traeger Leipzig 1914, p. 444-494.

Insights from modern sediments (Black and Baltic Seas plus oyster beds), role of oxygen, detailed paleontology (vertebrates, invertebrates, and bacteria) and water circulation, 60 years ahead of later widespread use

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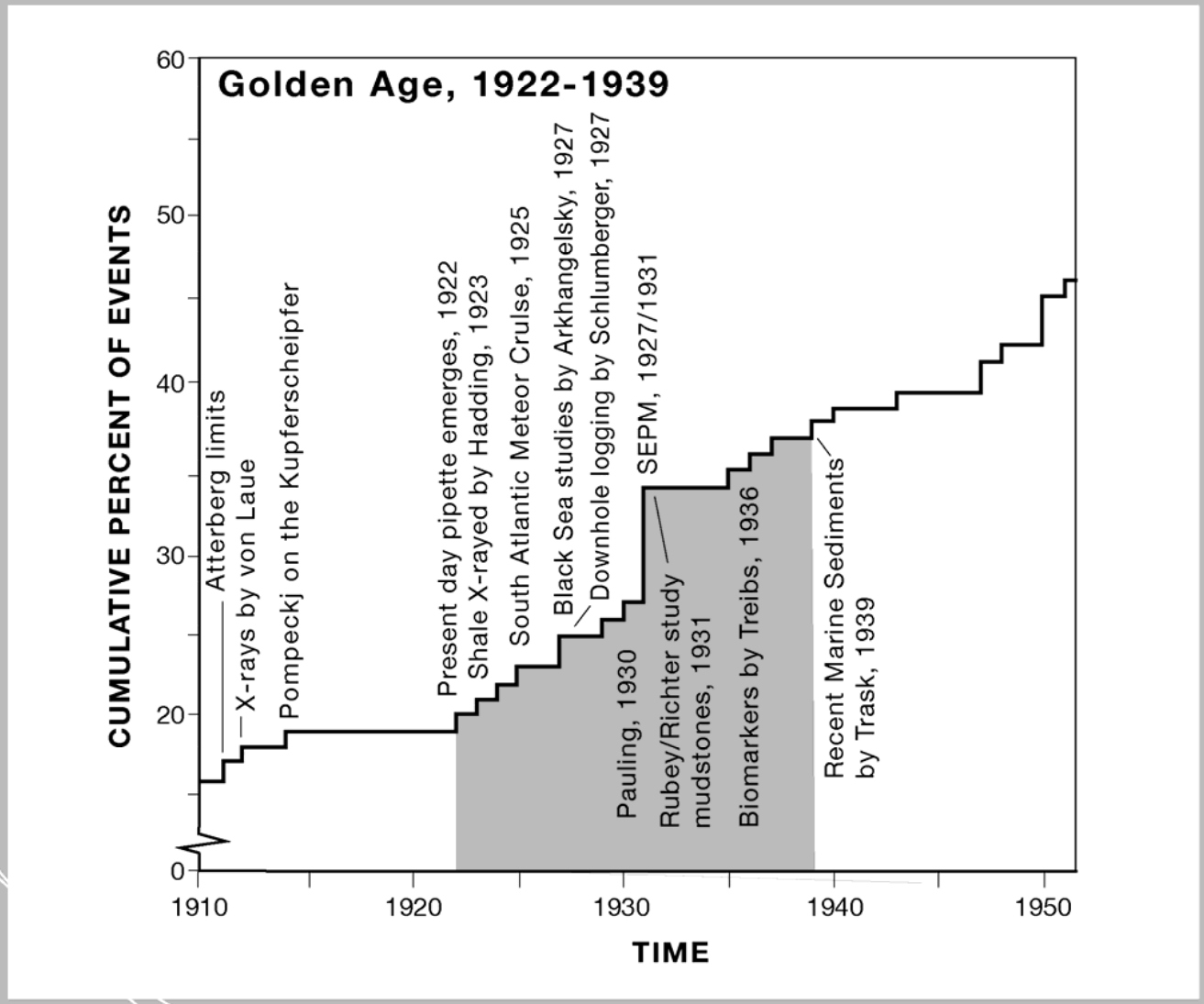
The Conditions of Black Shale Deposition as Illustrated by the Kupferschiefer and Lias of Germany

by **Charles Schuchert**

Proceedings of the American Philosophical Society, Vol. 54, No. 218 (Aug., 1915), p.259-269.



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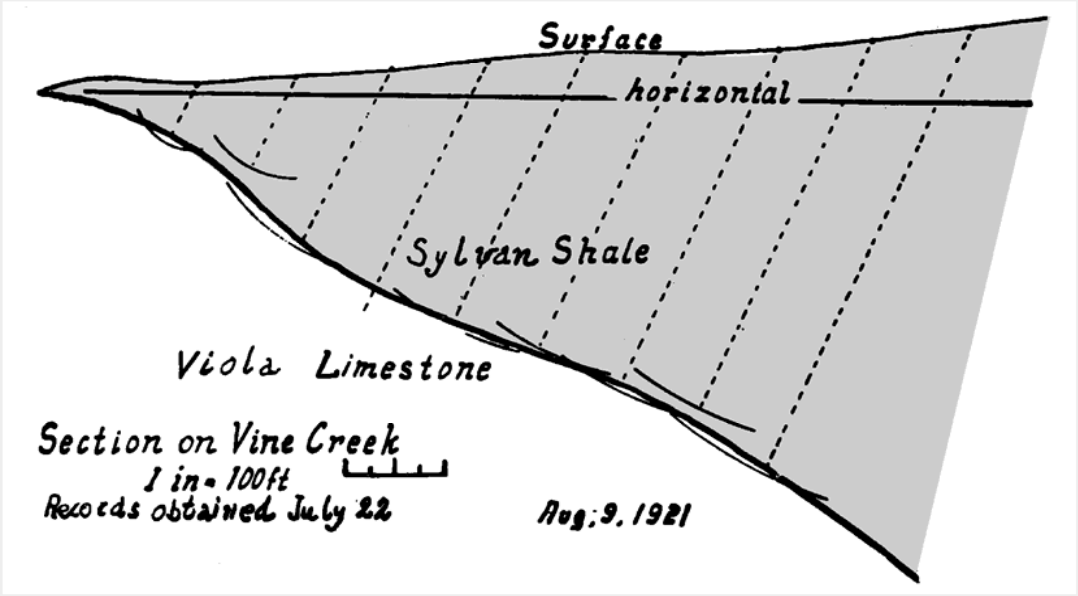
First Reflection Experiment in North America



Karcher's interpretation of his first reflection line

1894-1978

Introduction To Geophysical Prospecting

FOURTH EDITION

MILTON B. DOBRIN AND CARL H. SAVIT, 1988

Early Reflection Work The earliest experiments with the seismic reflection method were carried out by J. C. Karcher from 1919 to 1921. To demonstrate the potential of the method for oil exploration, he mapped a shallow reflecting bed in central Oklahoma early in 1921. On the fiftieth anniversary of this event, in April 1971, a monument (Fig. 1-2) was dedicated at the site where these tests had been conducted. Karcher was present at the ceremonies. Two of the first reflection records he shot there, as well as his interpretation of them, are shown in Fig. 1-3. Dobrin and SaviN(1988, Fig. 1-3)

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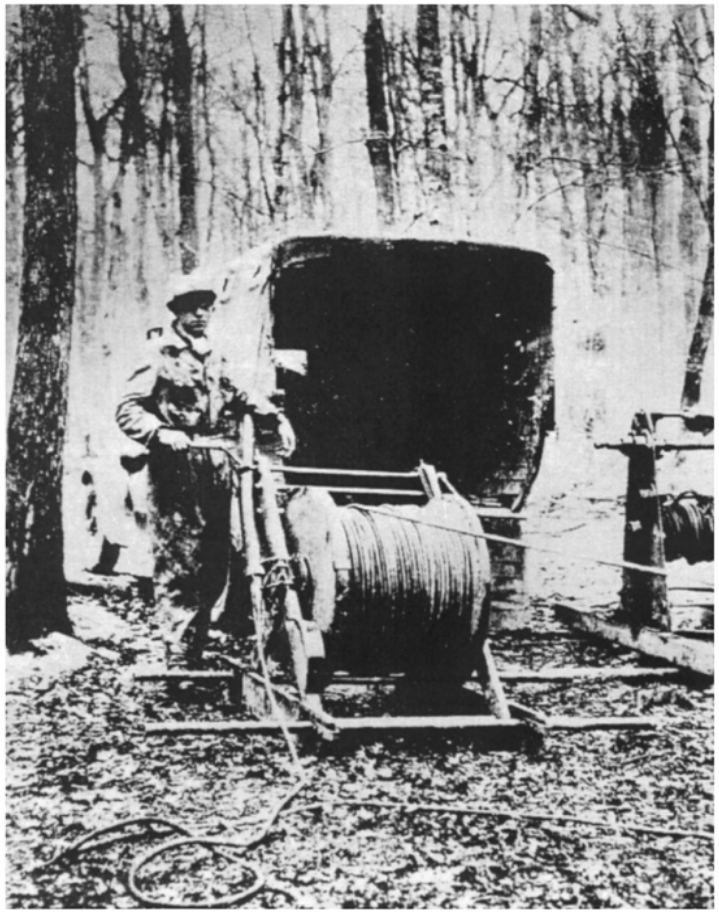

The winch, cable and pickup truck used in the beginnings of electrical coring at Péchelbronn near Paris in 1927. Alluad and Martin (1977)

The Structure of the Micas and Related Materials

by Linus Pauling

Proceedings of the National Academy of Sciences of the United States of America, v. 16, No. 2, p. 123-129 (Feb 15, 1930)

1901-1994

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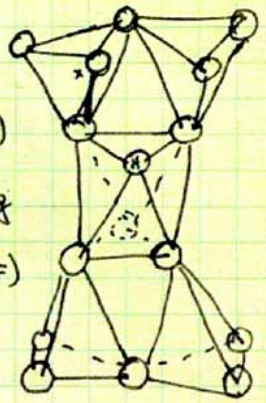
The Mica Group.

The structure which I suggest is the following:



A tetrahedral layer

A hydrargillite layer or a complete octahedral layer

A tetrahedral layer

These electrically neutral layers are simply piled together to give

Talc $Al_{2}^{(6)} Si_{4}^{(4)} O_{10}(OH)_2$

and Pyrophyllite $Mg_{3}^{(6)} Si_{4}^{(4)} O_{10}(OH)_2$. } I

Now $Si^{(4)}$ can be replaced in part by $Al^{(4)}$, introducing also K^+, Na^+ to preserve neutrality. This gives the micas:

Shorter Contributions to General Geology, 1930

Lithologic Studies of Fine-grained Upper Cretaceous Sedimentary Rocks of the Black Hills

by William W. Rubey

U.S. Geological Survey Professional Paper 165A, 54 pp.

1898-1974

Tierwelt um Umwelt im Hunsruckschiefer zur Enstehung eines schwarzen schlammsteins

by R. Richter

Senckenbergiana, 13,s. 229-342.(1931)

1881-1957

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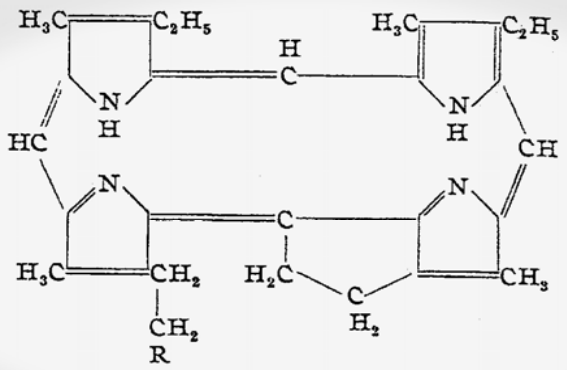
Chlorophyll~ und Häminderivate in Organischen Mineralstoffen

by Dr. Alfred Treibs

Angewandte Chemie
(Zeitschrift und Eignetum des Vereins Deutscher Chemiker)
v. 49, Jahrgang, p. 682-686. (1936)



I R = H. Desoxophyllerythro-ätioporphyrin.
II R = COOH. Desoxophyllerythrin.

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RECENT MARINE SEDIMENTS

A SYMPOSIUM

PARKER D. TRASK, Ed.

PREPARED UNDER THE DIRECTION OF A SUBCOMMITTEE OF THE COMMITTEE OF SEDIMENTATION OF THE DIVISION OF GEOLOGY AND GEOGRAPHY OF THE NATIONAL RESEARCH COUNCIL, WASHINGTON, D.C.

CARL W. CORRENS, STINA GRIPENBERG, W. C. KRUMBEIN, PH. H. KUENEN, OTTO PRATJE, ROGER REVELLE, F. P. SHEPARD, H. C. STETSON, PARKER D. TRASK, CHAIRMAN

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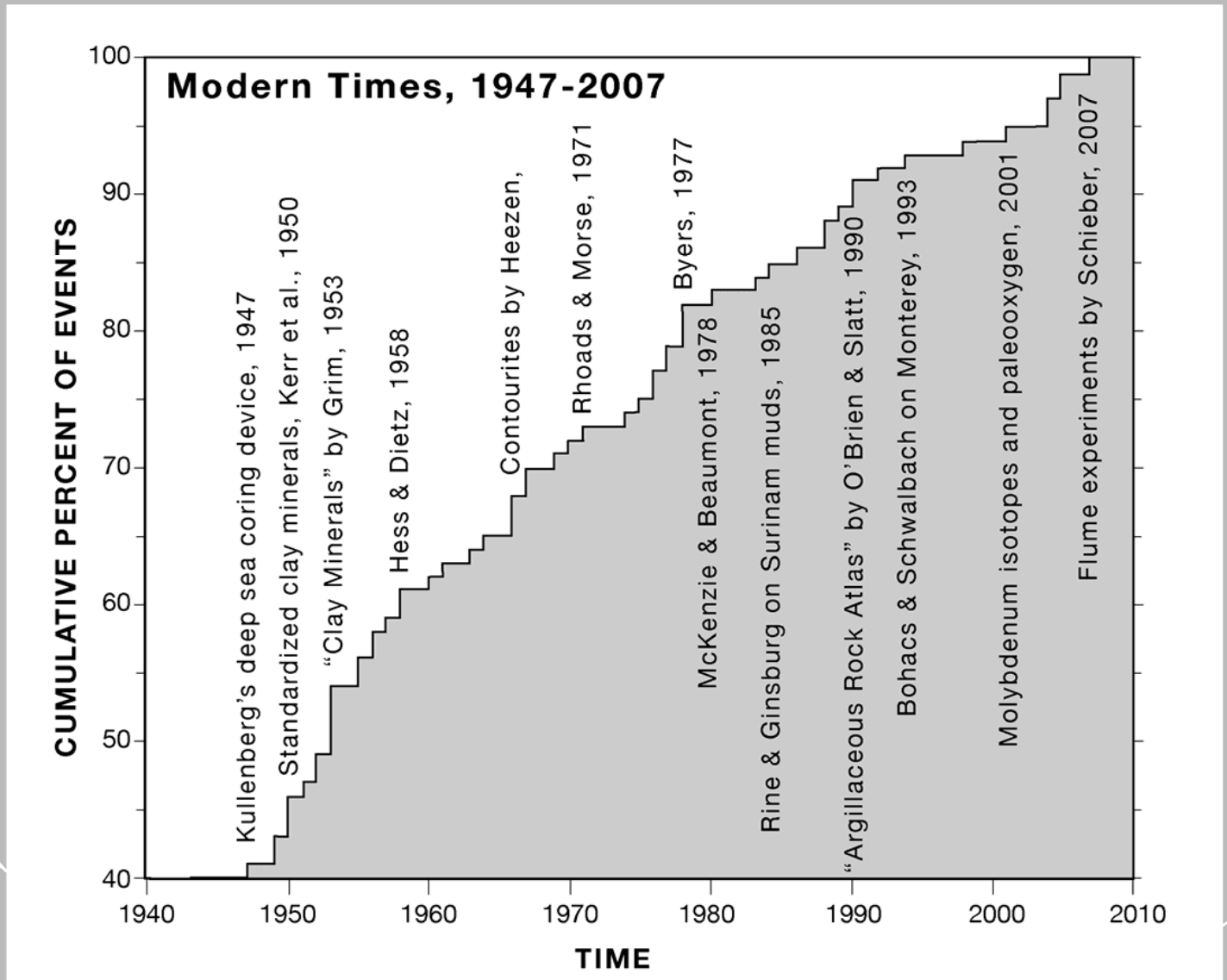
AAPG/Thomas Murby & Co. London, 1939
736 p.



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Analytical Data on Reference Clay Minerals

by P.F. Kerr, et al.

American Petroleum Institute, Project 49, Clay Mineral Standards, Columbia University, various paging, 1950

1897-1981

Clay Minerology

by Ralph E. Grim

334 p., 1953

1902-1989

University of Cincinnati

SOIL CHEMICAL ANALYSIS -- ADVANCED COURSE

BY

M. L. JACKSON

Professor of Soil Science

A manual of methods useful for instruction and research in soil chemistry, physical chemistry of soils, soil fertility, and soil genesis

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Revised from Original Edition of 1956

Procedure

2-56. Removal of Fe_2O_3 from sample.--A suitable amount of the sample, containing 0.5 gm of extractable Fe_2O_3 or less, is placed in a 100-ml centrifuge tube and 40 ml of 0.3 M Na-citrate solution and 5 ml of 1 M $NaHCO_3$ solution are added. (These solutions can be combined ahead of time.) The temperature is brought to 75 to 80°C (not more!) in a water bath, then 1 gm of solid $Na_2S_2O_4$ is added by means of a spoon, and the mixture is stirred constantly for one minute and then occasionally for 5 minutes.

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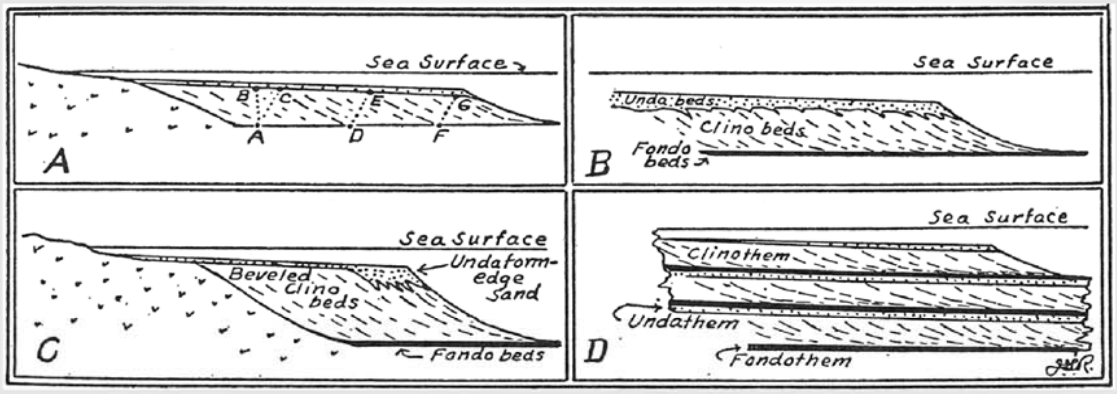
Three Critical Environments of Deposition, and Criteria for Recognition of Rocks Deposited in Each of them

by John Lyon Rich

Geological Society of America, v. 62, p. 1-20, (1951)

1886-1956



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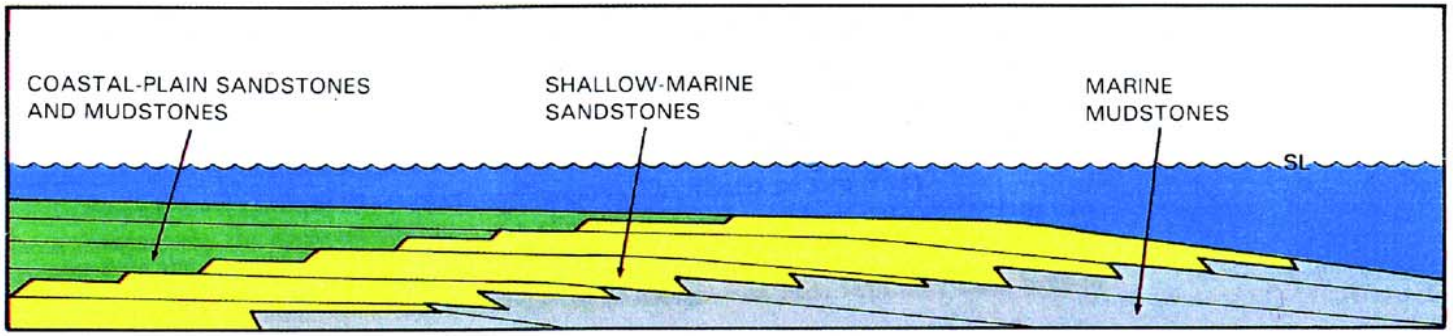
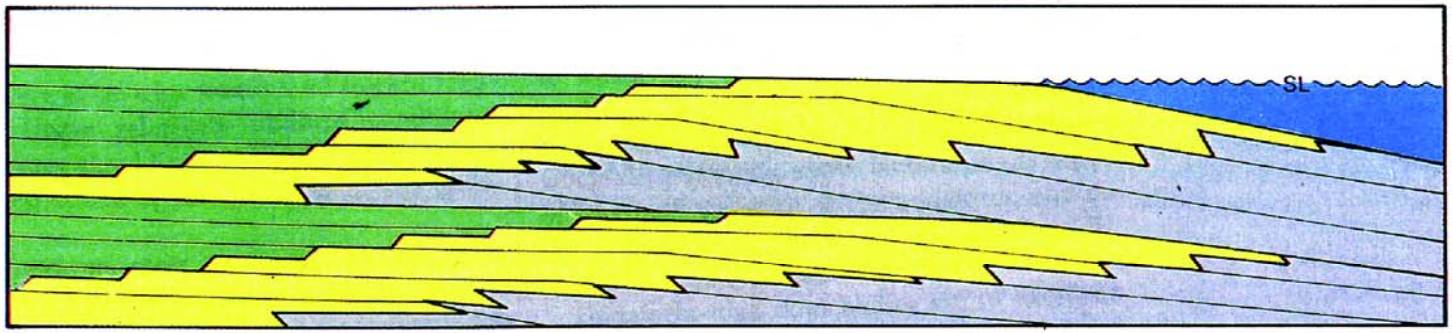


STAGE TWO

RAPID WATER-DEPTH INCREASE FLOODS THE TOP OF PARASEQUENCE



STAGE THREE

PROGRADATION PARASEQUENCE

Van Wagner et al., (1990, Fig. 4)

Evolutionary and Ecological Significance of Oxygen-Deficient Marine Basins

by Donald Rhoads and John W. Morse

Lethaia, v. 4, p. 413-428 (1970)

Biofacies Patterns in Euxinic Basins: A General Model

by Charles W. Byers

SEPM Special Publication, No. 25, p. 5-17 (1977)

MAIN IDEA: Mapping oxygen biofacies (relative abundance of fossils and their traces, diversity and size gradients, stratification, etc.) permits reconstruction of bottom contours and paleodip of basins

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Initial Reports of the Deep Sea Drilling Project

A Project Planned by and Carried Out With the Advice of the
JOINT OCEANOGRAPHIC INSTITUTIONS FOR DEEP EARTH SAMPLING (JOIDES)

Volume I, Leg 1, 672 p. (1969)

Maurice Ewing; J. Lamar Worzel; Arthur O. Beall; William A. Berggren; David Burky;
Creighton A. Burk; Alfred G. Fischer; Emile A. Pessagno, Jr.

Prepared By
NATIONAL SCIENCE FOUNDATION
UNIVERSITY OF CALIFORNIA
Scripps Institution of Oceanography
Prime Contractor for the Project

Maurice Ewing in 1948

Ewing called traditional geologists "annoying fellows who spend their time poking around trying to explain this or that little detail. I keep wanting to say, "Why don't you try to see what's making it all happen?"

Columbia Magazine,
Winter, 2001

1906-1974

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Depositional facies of a mud shoreface in Surinam, South America
A mud analogue to sandy shallow marine deposits

by J.M. Rine and R.N. Ginsburg

Potter et al. (2005, Fig. 5.33D)

Potter et al. (2005, Fig. 5.34D)

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John Dunham, 1994

Chapter II - Sequence Stratigraphy of Fine-Grained Rocks with Special Reference to the Monterey Formation

by Kevin M. Bohacs and Jon R. Schwalbach

SEPM Pacific Section, v. 70, p. 7-19 (1992)

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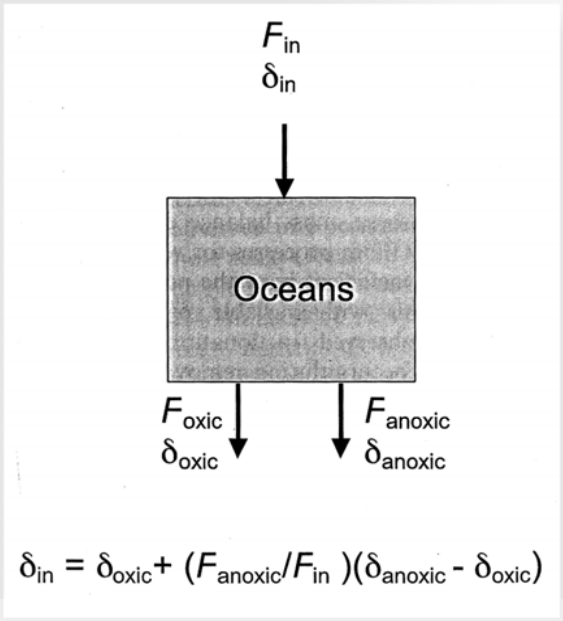
Natural Mass-Dependent Variations in the Isotopic Composition of Molybdenum

by Barlings, J., Arnold G.L. and Anbar, A.D.

Earth and Planetary Sciences Letters,
v. 193, p. 447-457 (2001)



$$\delta_{in} = \delta_{oxic} + (F_{anoxic}/F_{in})(\delta_{anoxic} - \delta_{oxic})$$

Possible pathway to *quantitative paleoxygen* gives a number that can be checked against more qualitative paleoxygen proxies in the rock record (bioturbation, fossil size, faunal diversity, stratification, color, pyrite content and types, and organics)

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Final Thoughts

Comparisons, Conclusions
Looking for The Big Ideas,
Musings.....

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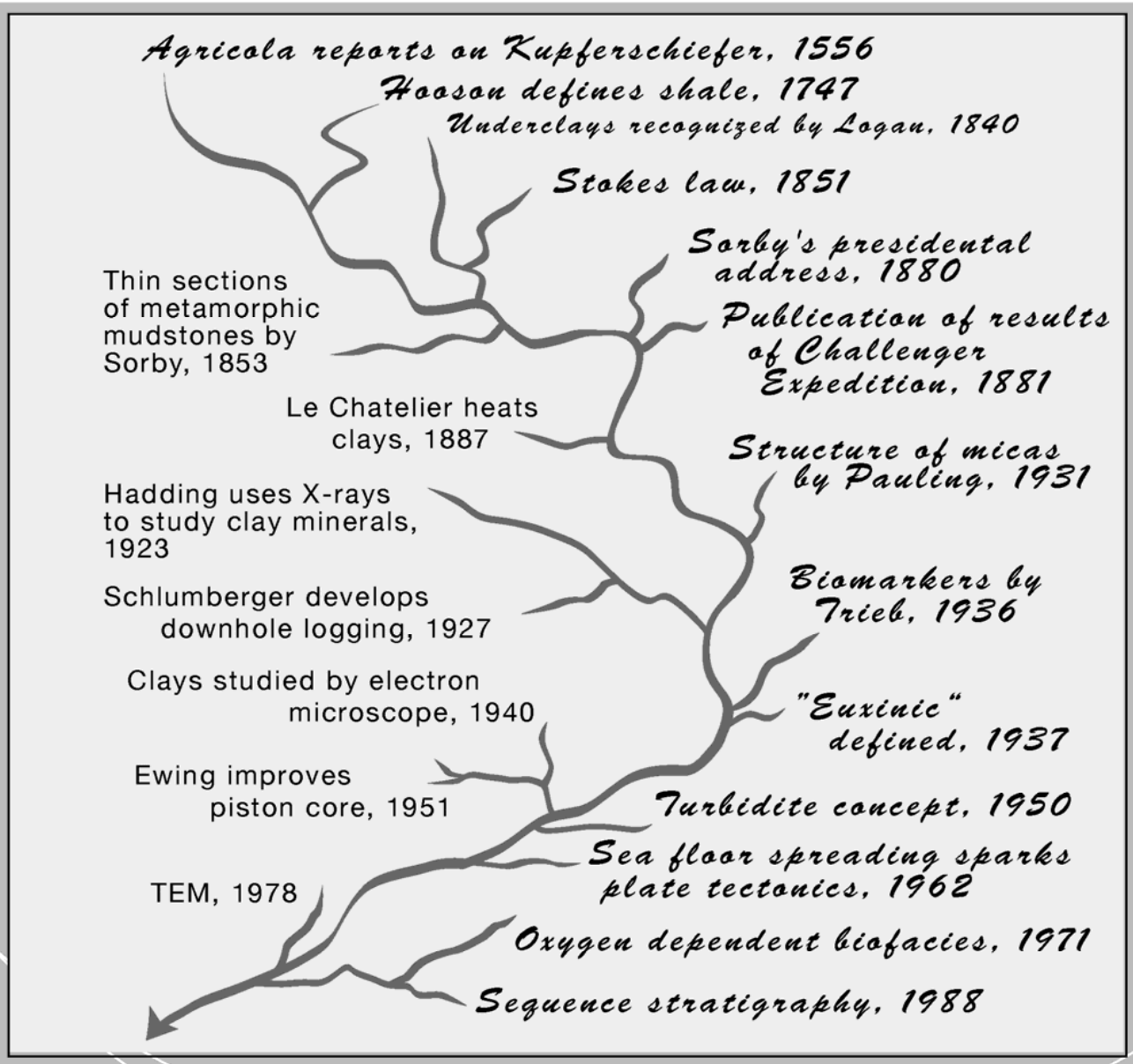

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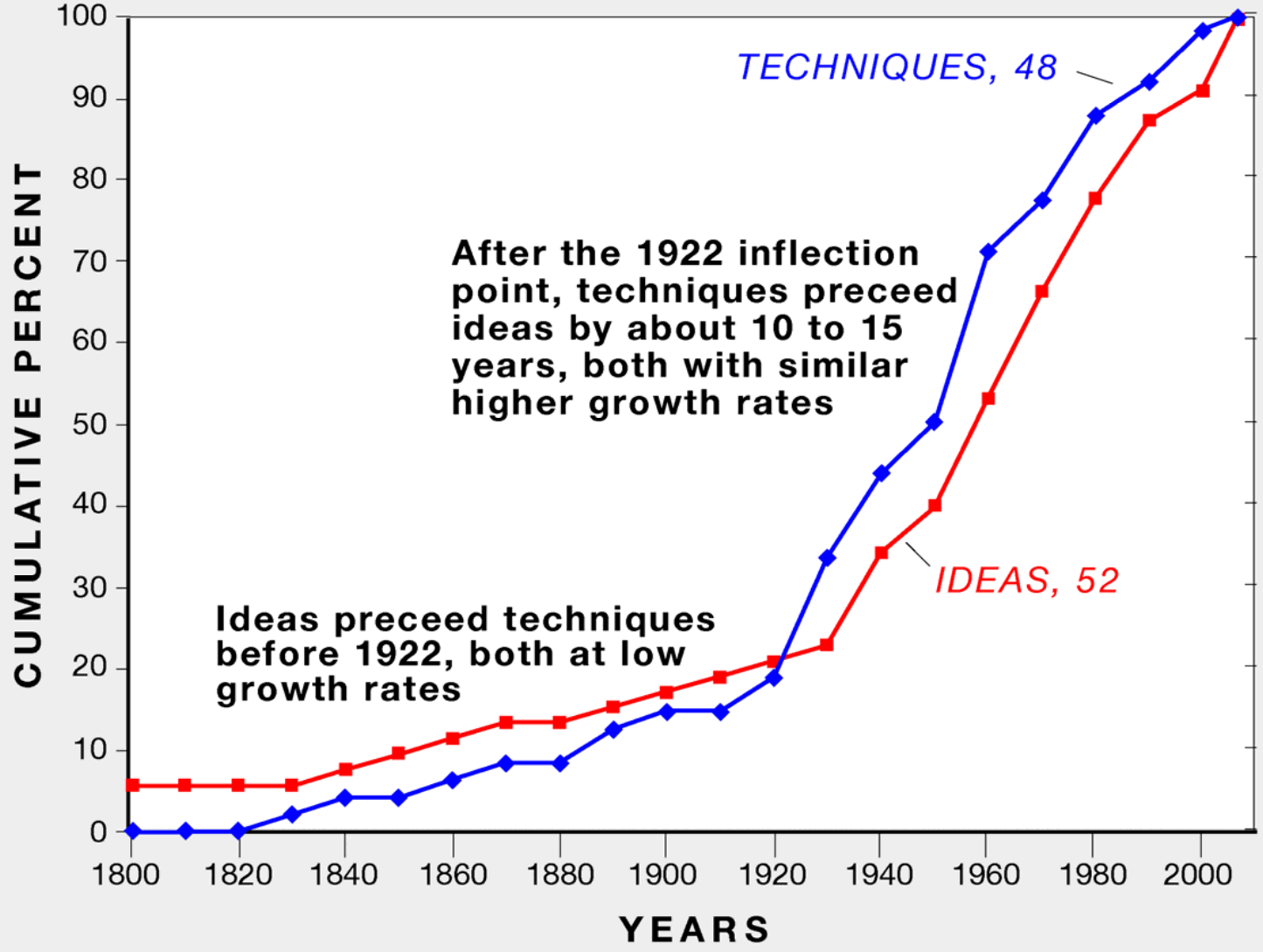

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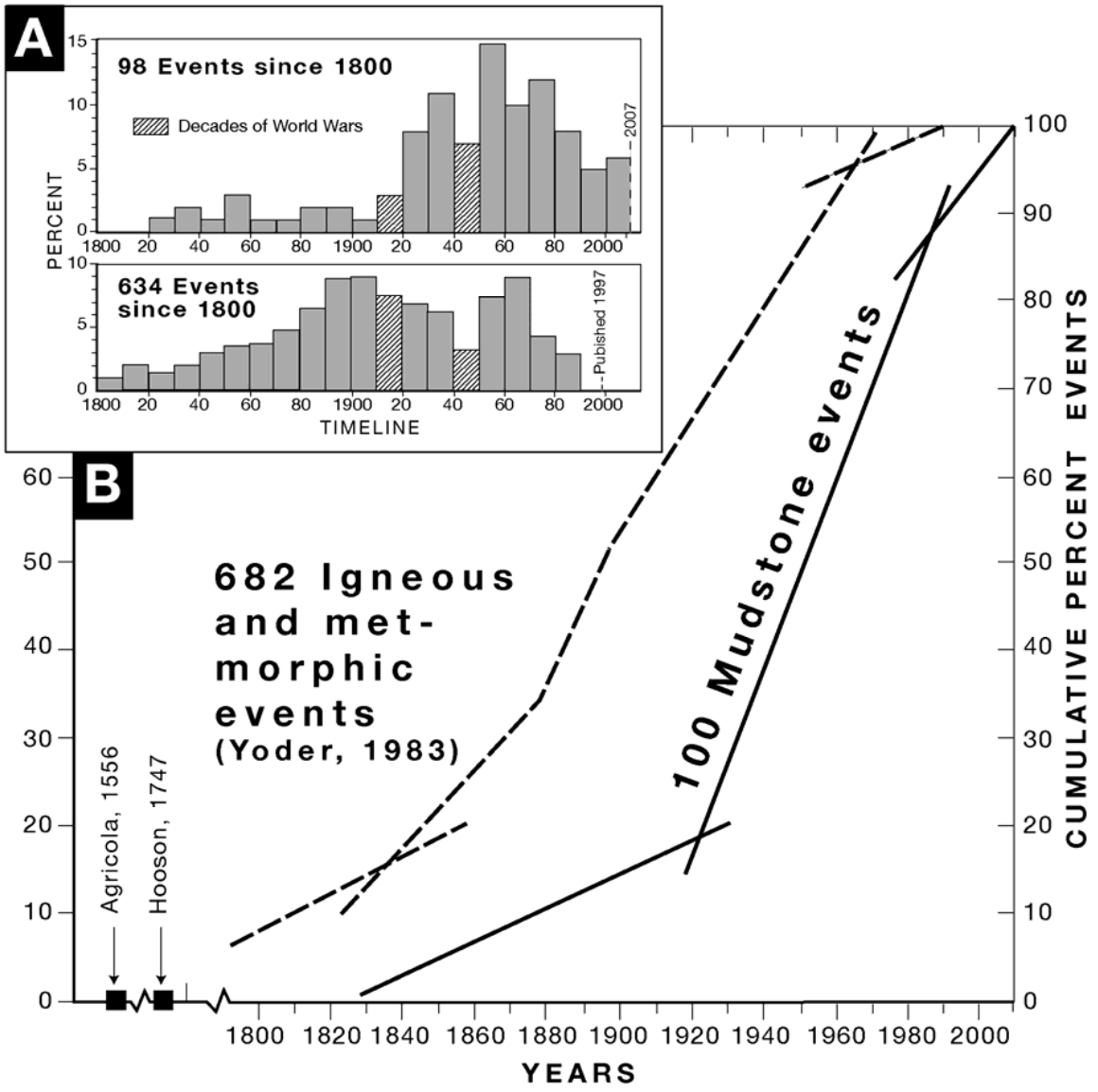

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Principal Conclusions

1. Nineteen twenty two marks the great inflection point from earlier study based on field observation, microscopic examination and wet chemistry to the common use of insrumental methodologies imported from physics and chemistry
2. These imports were significant, because they expanded greatly our range of observation - *if you can't "see" or measure something, you don't think of it and thus can't use it to solve a problem*
3. Nineteen twenty two to 1939 was the "Golden Age" for mudstone studies followed by renewed activity after WW II
4. Since 1922 instrumental advances have generally preceeded analytical, conceptual, and synthesis studies
5. The two world wars and the Great Depression all affected developments in mudstone science