"THE SOCIAL ORGANIZATION OF SCIENCE"

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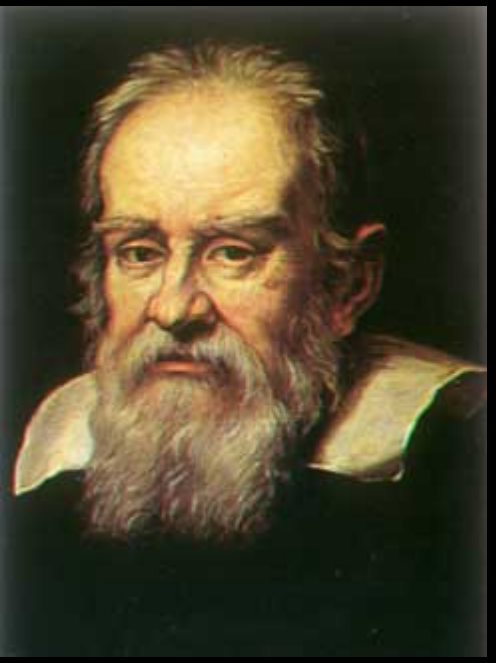
MNF990 UiB PhD courses, MatNat faculty 2018

THE SCIENTIFIC REVOLUTION

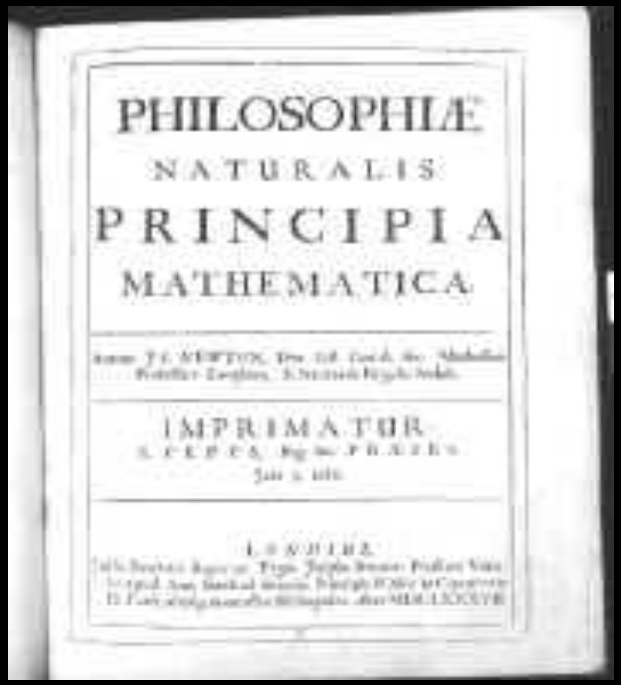


- About 1550-1750
- Mainly in Italy, France, England, and central Europe
- By important scientists: Galileo Galilei; Nicholas Copernikus; Robert Boyle; William Harvey; Isaac Newton etc.
- Support from philosophy: Francis Bacon, René Descartes;

EXPERIMENT, OBSERVATION AND MEASUREMENT AS METHOD

- Justification through what can be experienced; empirical basis.
- Nature's two "books"
- All of reality as object of study and understanding
- Manipulation in order to squeeze out hidden truth
- Instruments to improve perception

NUMBERS AND QUANTIFICATION:

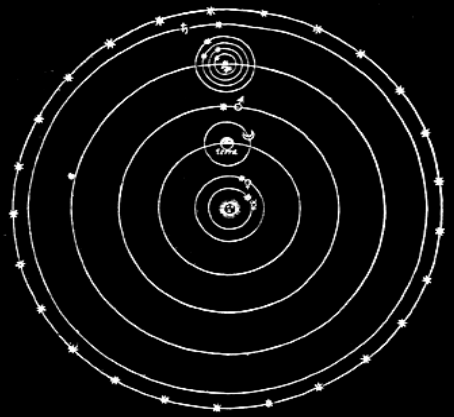

PHILOSOPHIÆ
NATURALIS
PRINCIPIA
MATHEMATICA

IMPRIMATUR

- During Renaissance a revival of Platonic thought
- Quantities allow for precise measurement
- Mathematical regularities as the language of Nature
- Analysis and synthesis
- Macro and micro

SEARCH FOR THEORY

- Unifying perspectives on natural variability
- Looking for underlying causes
- Breaking through the surface of phenomena



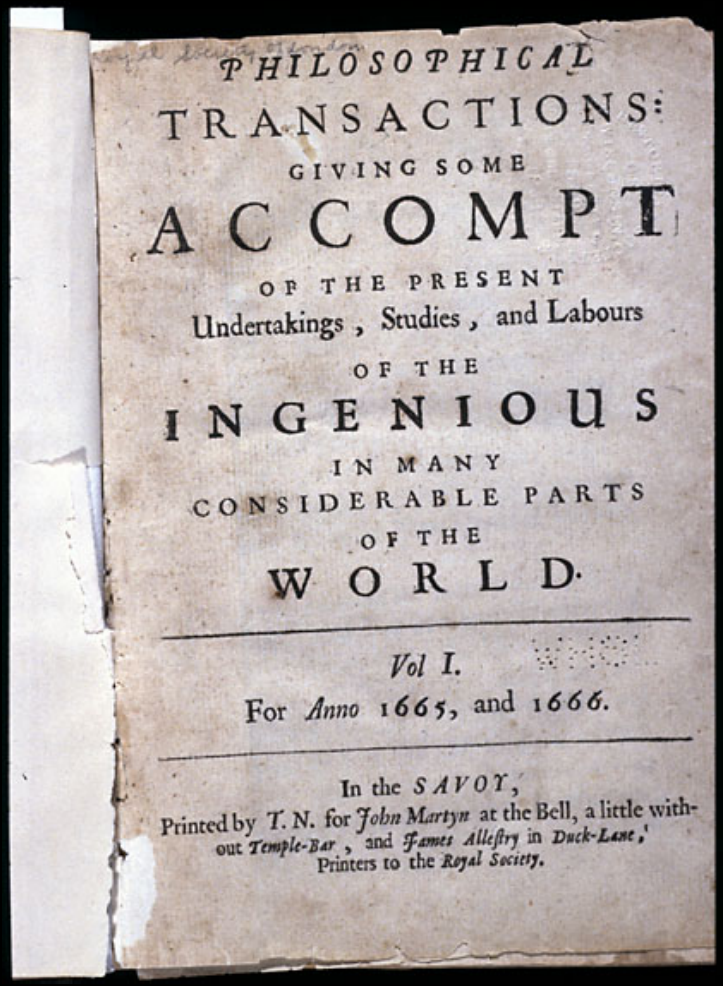
SOCIALLY ORGANISED ACTIVITY:

- Several scientific societies or academies were founded nearly at the same time in Italy, England and France.
- For the pursuit of natural philosophy and experiment
- Impressed by technological advances

THE NEED TO JUSTIFY THE NEW ORGANIZATION:

- ”The business and design of the Royal Society (is) to improve the knowledge of natural things, and all useful Arts, Manufactures, Mechanick practices, Engynes, and Inventions by Experiments, - (not meddling with Divinity, Metaphysics, Moralls, Politicks, Grammar, Rhetorick, or Logick).”
- Consequence: Church (owner of universities) can relax;
  King can relax, occupying an empty space.
- Believing it (or not?) – did it matter?

PUBLIC KNOWLEDGE:



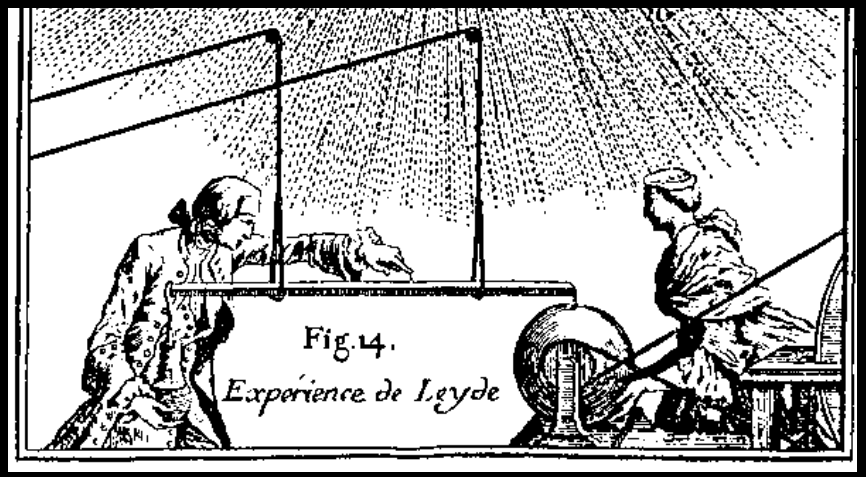
PHILOSOPHICAL
TRANSACTIONS:
GIVING SOME
ACCOMPT
OF THE PRESENT
Undertakings, Studies, and Labours
OF THE
INGENIOUS
IN MANY
CONSIDERABLE PARTS
OF THE
WORLD.

Vol I.
For Anno 1665, and 1666.

In the SAVOY,
Printed by T. N. for John Martyn at the Bell, a little without Temple-Bar, and James Allestry in Duck-Lane, Printers to the Royal Society.

- Universal science
- Test of knowledge claims through peers
- Birth of the scientific journal
- For the benefit of all
- No secrecy
- Insure priority of discovery
- Inspired by Arts and Crafts of the Renaissance (Da Vinci etc)

PROGRESS OF KNOWLEDGE:



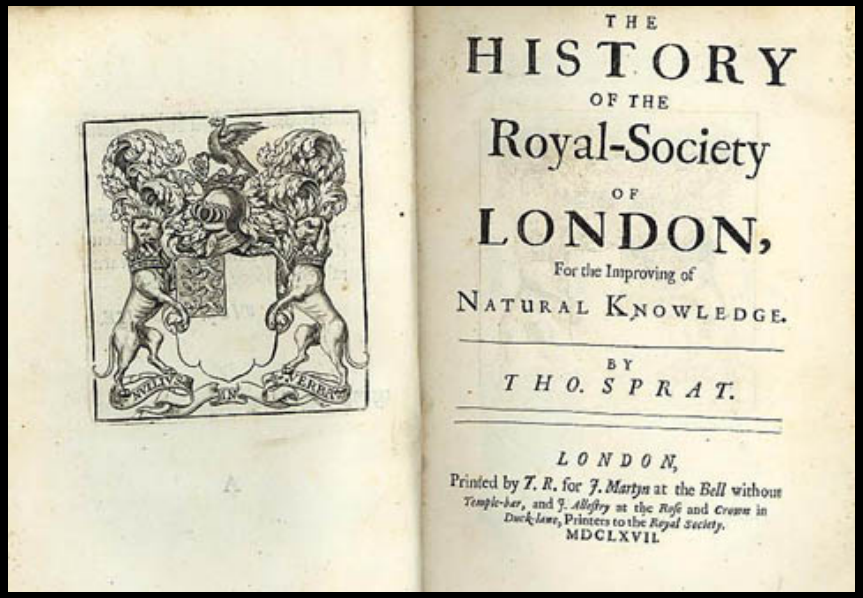
- Standing on the shoulders of giants !
- Dispute about the ancients and the moderns
- Belief in infinite progress of knowledge (B. de Fontenelle)

BUT IN REALITY? WHAT HAPPENED THE NEXT 200 YEARS?

- No influence on technology and «innovation»
- Worldviews, politics, and morality changed under the influence of science (Enlightenment, education: common schools, social order, Darwin and religion, …)

FOUR EPOCHS OF SCIENCE?

- Amateur science
- Professional science
- Industrial science
- Big Science


THE
HISTORY
OF THE
Royal-Society
OF
LONDON,
For the Improving of
NATURAL KNOWLEDGE.
BY
THO. SPRAT.
LONDON,
Printed by T. R. for J. Martyn at the Bell without Temple-bar, and J. Allestry at the Rose and Crown in Duck-lane, Printers to the Royal Society.
MDCLXVII.

AMATEUR SCIENCE:

- Seperated from universities
- Mainly as spare-time activity of men
- Independent income
- Partially sponsored by wealthy individuals with special interests
- Later the entertainment in French Salons

PROFESSIONAL SCIENCE:

- Starts with Humboldt University 1810 in Berlin
- Integration of education and research
- Education of public officials and administration
- Part of the larger culture

INDUSTRIALISED SCIENCE:

Pasteur und Metschnikow (stehend) mit Kindern, die von der Tollwut geheilt wurden

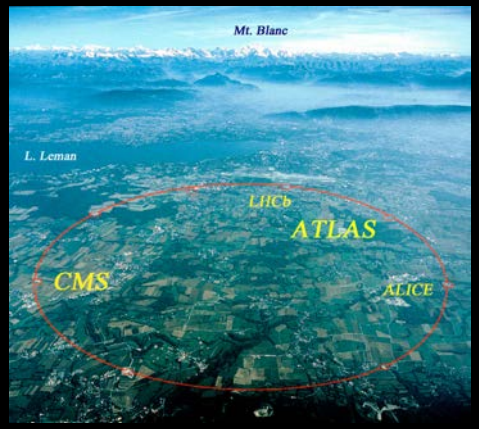
- At the end of the 19th Century.
- Recognising the technological potential of science
- In line with the dominant view of progress
- Industrial institutes organised alongside the universities
- Chemical industry; Kaiser Wilhelm Institut, etc.

BIG SCIENCE:

- Starts with 2nd World War
- Manhattan Project
- Collective enterprise towards common goal
- Management system
- Goal from outside science

MORE ON: BIG SCIENCE:

- Manhattan project
- Hitler's rocket program at Peenemünde
- More followed: … Cancer, Artificial Intelligence, Human genome project ,…



EXCURSION ON PHILOSOPHY OF SCIECNE TRADITIONS:

The 20th century

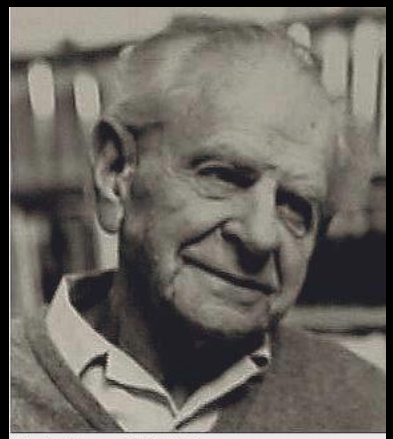
UNDERSTANDING SCIENCE (1) ~1920-1960: POSITIVISM

- Anti metaphysics
- Inductivist
- Verification theory of meaning
- Theoretical and empirical concepts
- Observation statements as basis
- Logic as structure
- Ethics outside rationality

RETHINKING SCIENCE IN THE 1960'S (2):

Fallibilism and critical rationalism

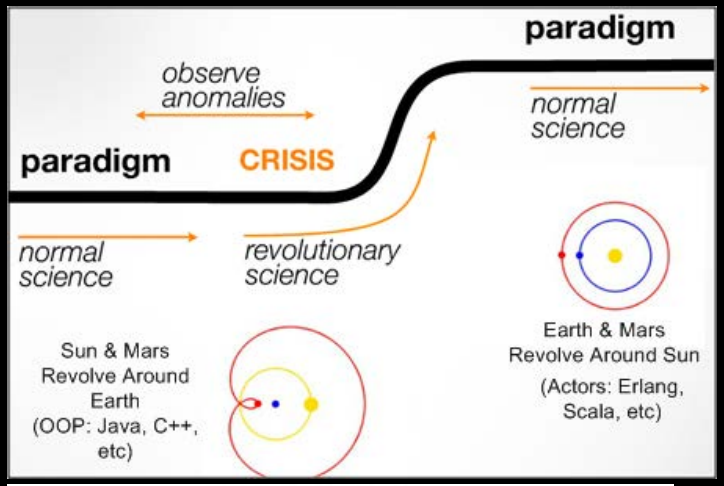
- Popper: bold hypotheses + rigorous attempts at falsification; "animal farm move" (all theories are false but some are falser than others)
- Enforces objectivity, and replaces certainty with proximity to truth.
- Scietific method becomes the instrument of criticism in a free society, and is therefore only a matter of rationality, not ethics.



Sir Karl Popper (1902-1994)

KUHN AND PARADIGMS:

- Restricts himself to natural science
- Science as puzzle-solving
- Normal science versus revolutionary science
- All normal science presupposes a paradigm
- Paradigms are never falsified, only replaced
- Proofs only meaningful within a given paradigm
- Paradigms are built around exemplars of method and inquiry.



RETHINKING SCIENCE IN THE 1960'S (3):

- Thomas Kuhn & normal science paradigms
  - Challenged various philosophical standard conceptions of science;
  - Brought science close to "ideology" or purely metaphysical beliefs.
- Derek De Solla Price & Big Science
  - Challenged the presumed autonomy of purely internal problem generation within science;
  - Showed social organisation of knowledge production to be interwoven with external aims.
- J.D. Bernal & socialised science policy
  - Challenged the presumed value-freedom of science policy & proposed a science for the good of society, informed by ethics.
  - Assumed that science left to its own might not produce a universal Good.

THE ”BERMUDA-TRIANGEL” IN PHILOSOPHY OF SCIENCE

Thomas Kuhn

Positivism
logical empiricism
new-positivism
Vienna Circle

Popper

FROM CONTINENTAL DRIFT TO PLATE TECTONICS – 1912-1967

Brief history

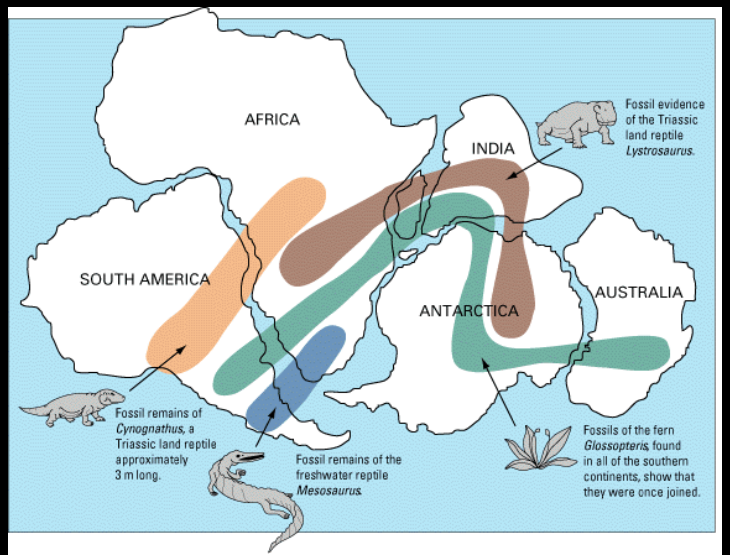
CONTINENTAL DRIFT & ALFRED WEGENER (1880-1930).

- Alfred Wegener – an outsider with a popular idea.
- 1905: dr degree in astronomy
- 1908 privatdozent meteorology
- Marburg, Hamburg, Graz
- J.P.Koch & Wegener crossing Greenland: 1906, 1912-13; (1930).

The last photograph of Alfred Wegener, together with his companion Rasmus Villumsen, taken on November 1, 1930, at "Mid-Ice" before they left on their ill-fated trip back to the West Station. The temperature was approximately −50° C.

Up, up, and away—the Wegener family aloft, April 17, 1912. From left to right: Alfred Wegener, Kurt Wegener, Else Köppen, Tony Wegener.

Grooves carved by glaciers (shown by arrows) provided evidence for continental drift. This diagram assumes the continents were in their present-day locations.



NOTE:

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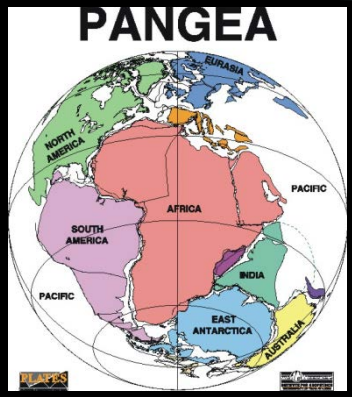
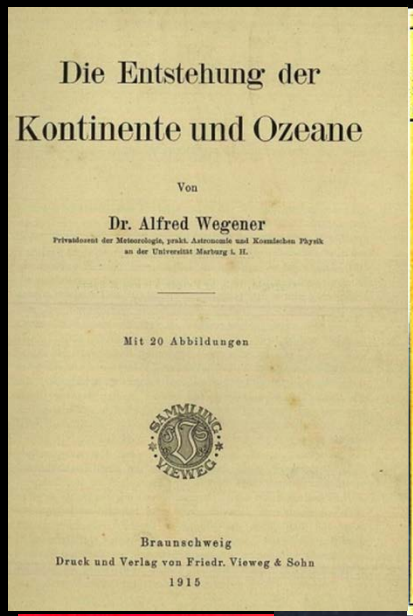
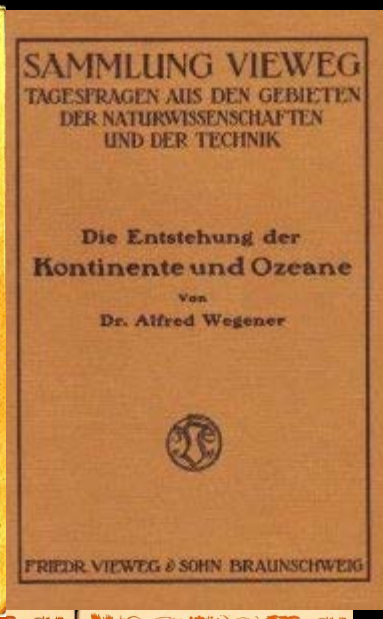


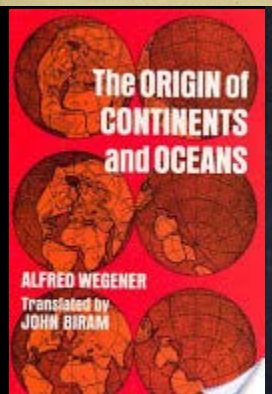
Book appeared in 1915, 1922, 1924, 1929

Translated into: English, French, Swedish, Spanish,

Russian, Chinese,...

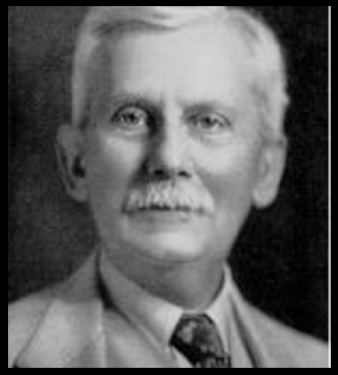


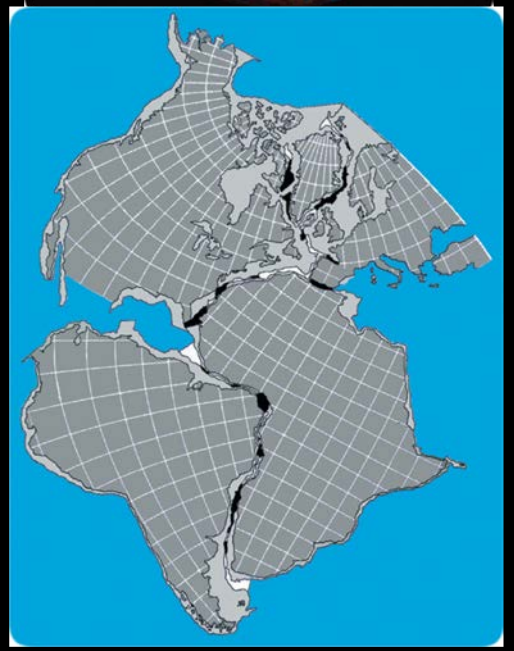




1926 A CONFERENCE TO MAKE A ”FINAL” JUDGEMENT IN NEW YORK.

- Charles Schuchert ”I shall now perform a small test of contintal drift theory…”
- 1964 London ”Continental drift?” Sir Edward Bullard.



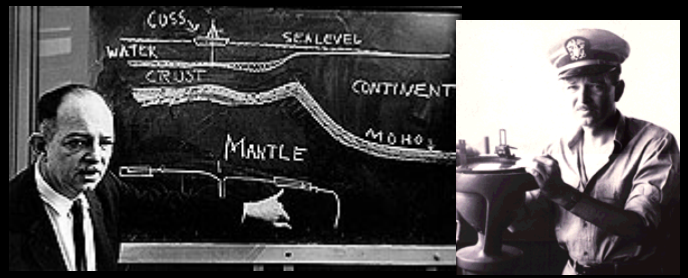


NEW SCIENTISTS ENTER THE DEBATE

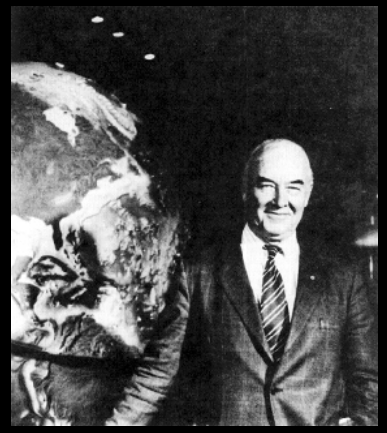
- Patrick Maynard Stuart Blackett (Baron Blackett) (1897-1974)

- Keith Runcorn (1922-1995)

- Harry Hess (1906-1969)



- Tuzo Wilson (1908-1993)



the polar wandering paths based on rocks from these two continents is of especial interest. Figure 19 shows that the smooth curve passing through the American poles lies about 30° west of the British curve.

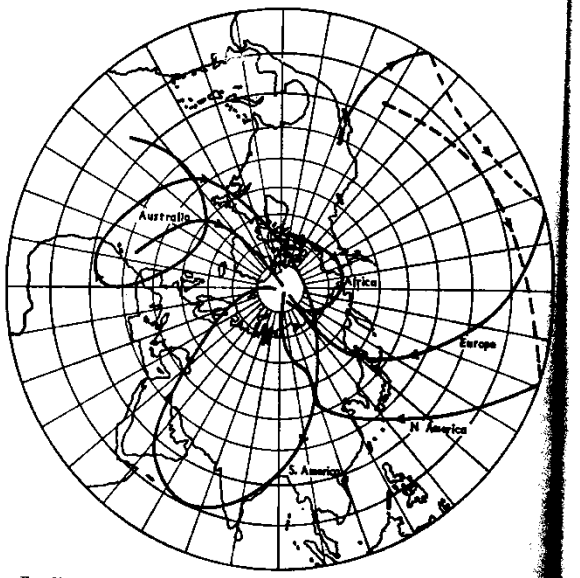


FIG. 20. Schematic polar wandering curves from all the continents. (Reproduced by permission from *Research*.) The curve for S. America is after K. M. Creer, *J. Geomagn. Geoelect., Kyoto*, 13, Nos. 3 and 4, 154–165 (1962).

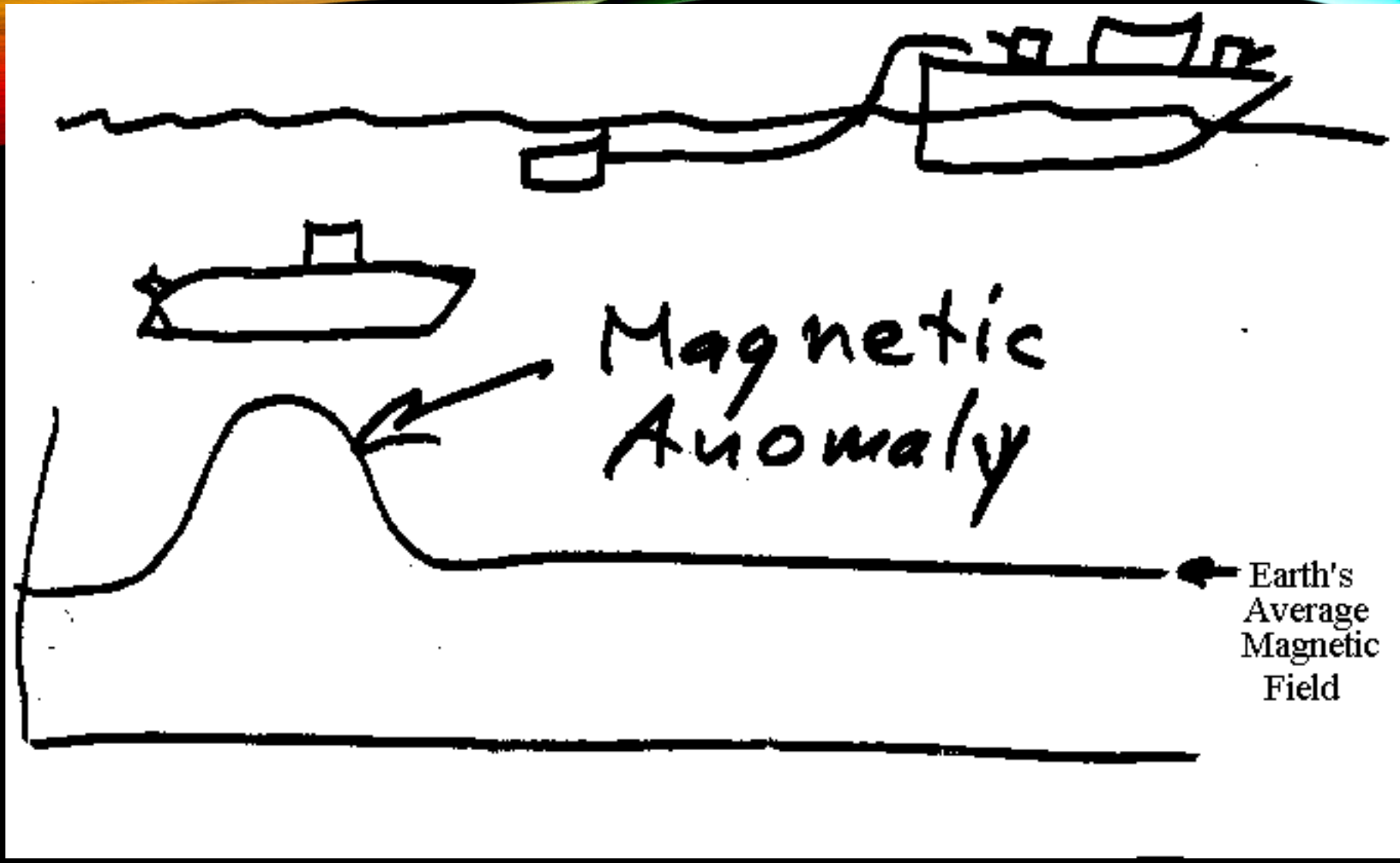
Figure 21, where the longitudes of the poles are plotted against geological time, shows this more clearly. It is possible to separate the European and American points almost completely by a straight line, and the separation is seen to exist until after the Triassic. It is clear that

A SMALL COMMUNITY OF OUTSIDERS

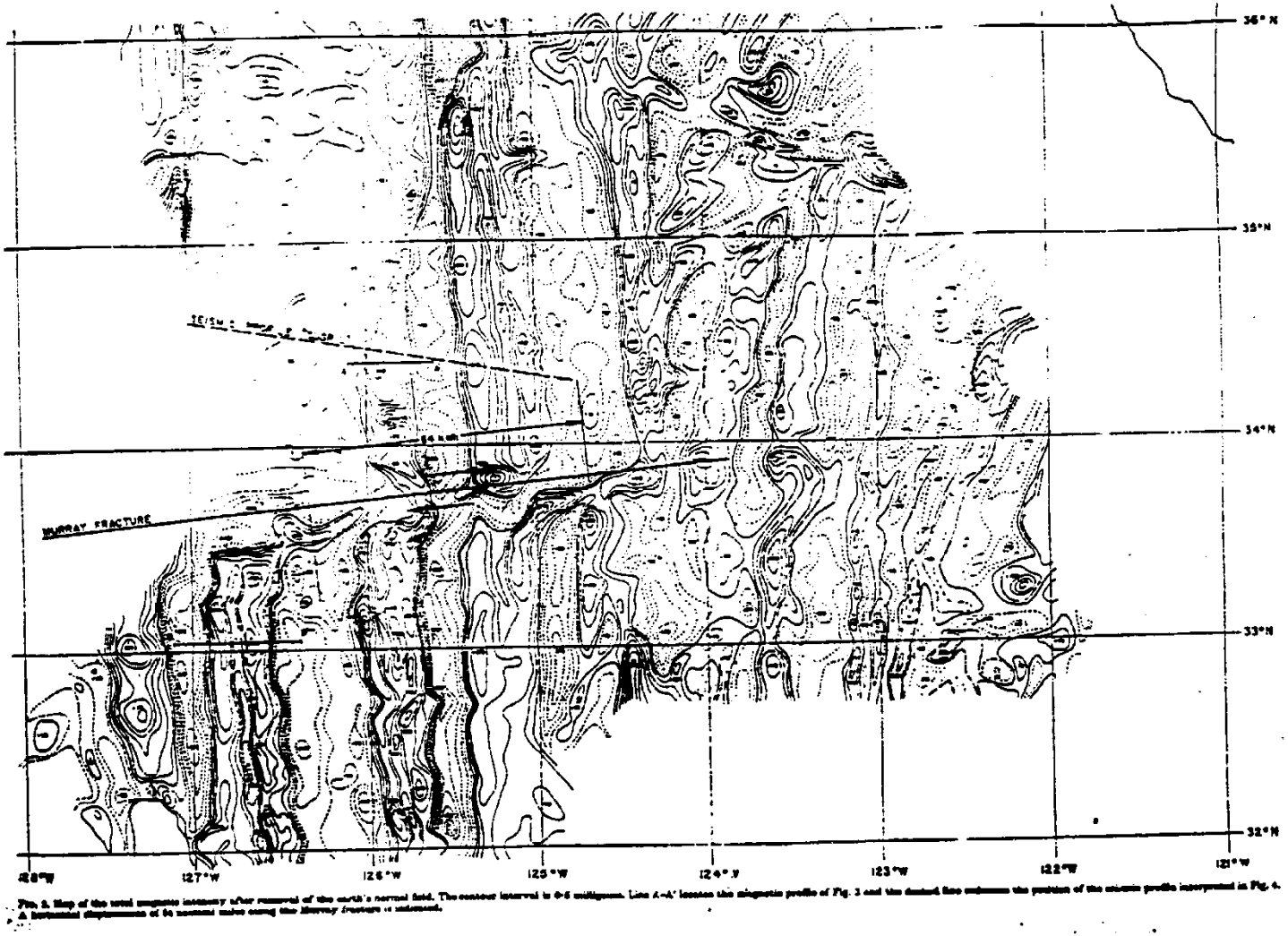
- Not favourably regarded by core science (geo-physics, etc)
- World gathering – see picture
- But Linus Pauling was among them

POST WAR OCEAN RESEARCH:

- ¾ of Earth's surface virtually unknown!
- 'Next war will be decided by sub-marines'
- «the US Navy had found that sound pulses used for locating enemy submarines also reflected from the seafloor, and the time taken for sound to travel down and back could be used to measure water depth"
- support from "the US Navy, which regarded knowledge of the seafloor as critical to the nation's defense interests during the "cold war." – until ca 1960
- Maurice Ewing – a pioneer.



Measure everything – use all the instruments you have!



?

FIGUR VII.5

[AUS RUNCORN 1962, S. 136]

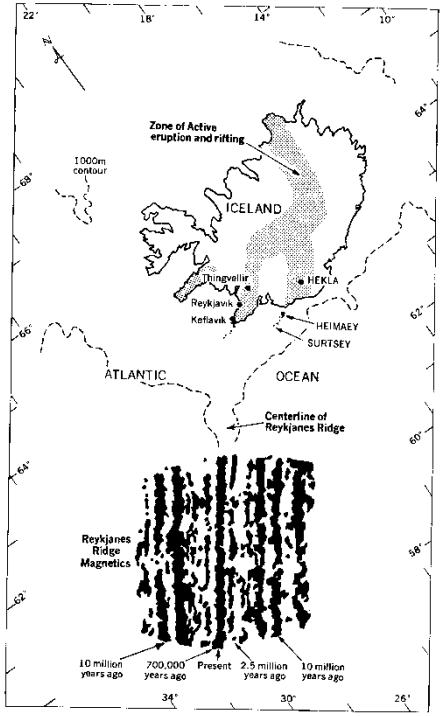


Figure 6.6 Magnetic features of Reykjanes Ridge. *A U. S. Navy plane flew fifty-eight passes perpendicular to the Reykjanes Ridge, located in southwest of Iceland, in order to map the region's magnetic patterns. The data obtained from the flights revealed an extraordinarily symmetrical pattern of magnetic features to either side of that ridge. Their ages, deduced from the timetable of worldwide magnetic field reversals, are shown.*

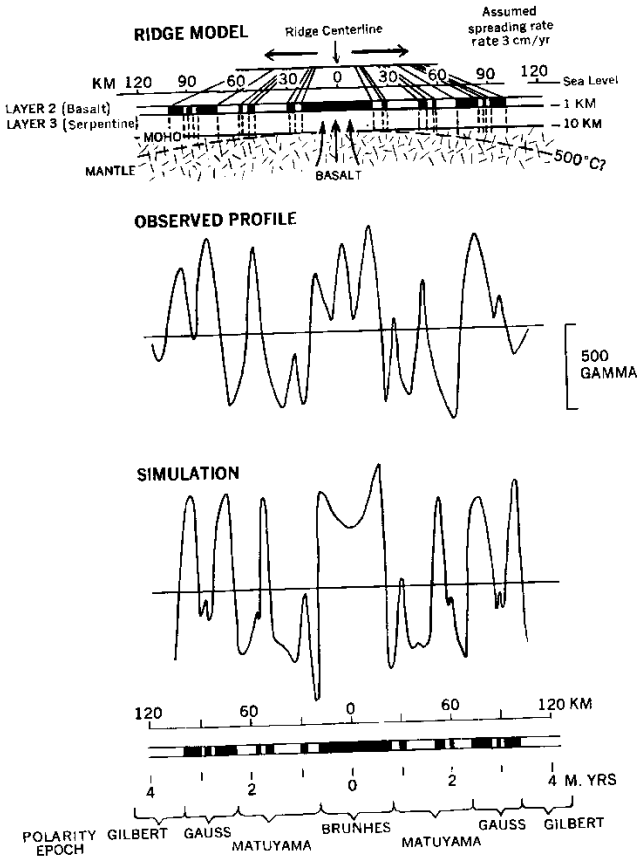
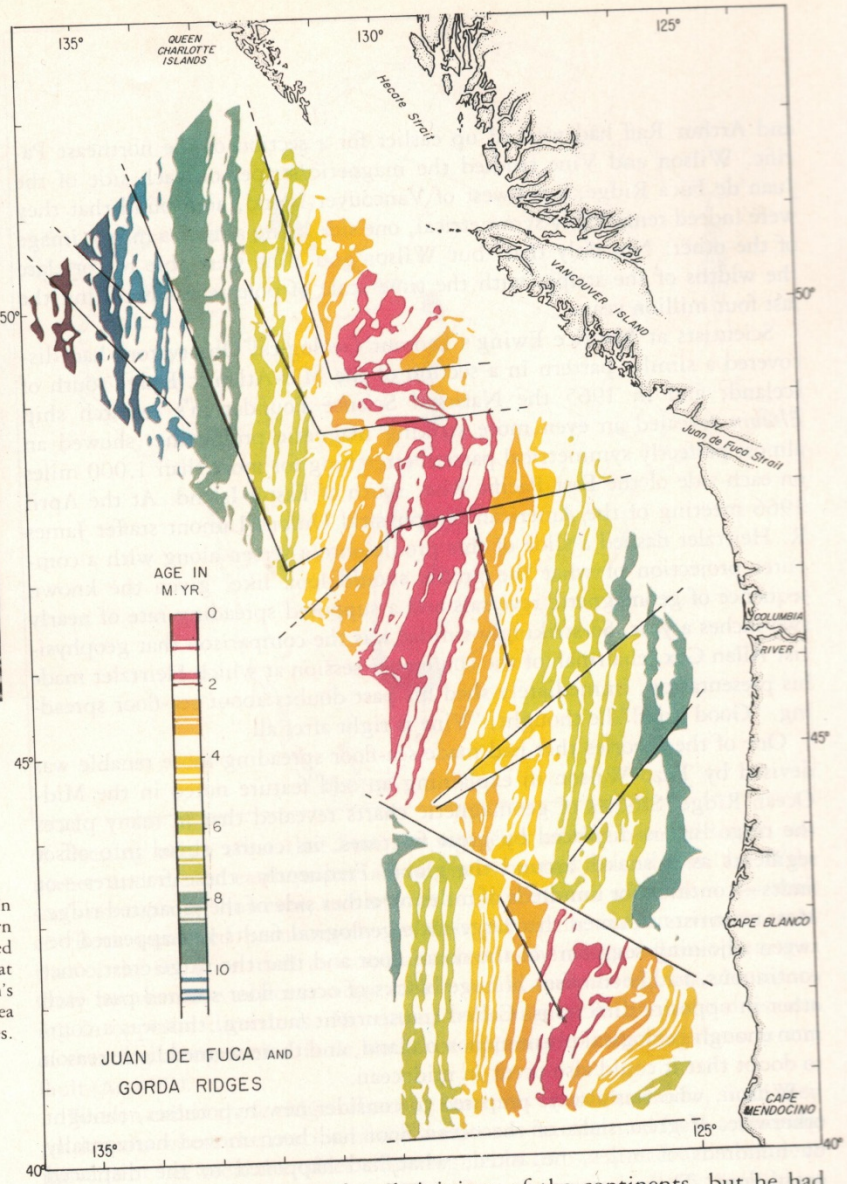


Figure 6.5 Magnetic intensity *as measured by ships crossing the Juan de Fuca Ridge, located on the Pacific floor off the Washington coast. F. J. Vine and J. T. Wilson found the observed profile resembled a computer-simulated profile. They based the construction of the computer simulation on the assumption that the sea floor was manufactured, symmetrically to either side of the ridge, and imprinted with the sequence of normal and reversed polarities of the earth's magnetic field as indicated by the timetable at the bottom of the illustration. While various spreading rates were tried in the simulations, the one that matched best was three centimeters (1.2 inches) a year.*

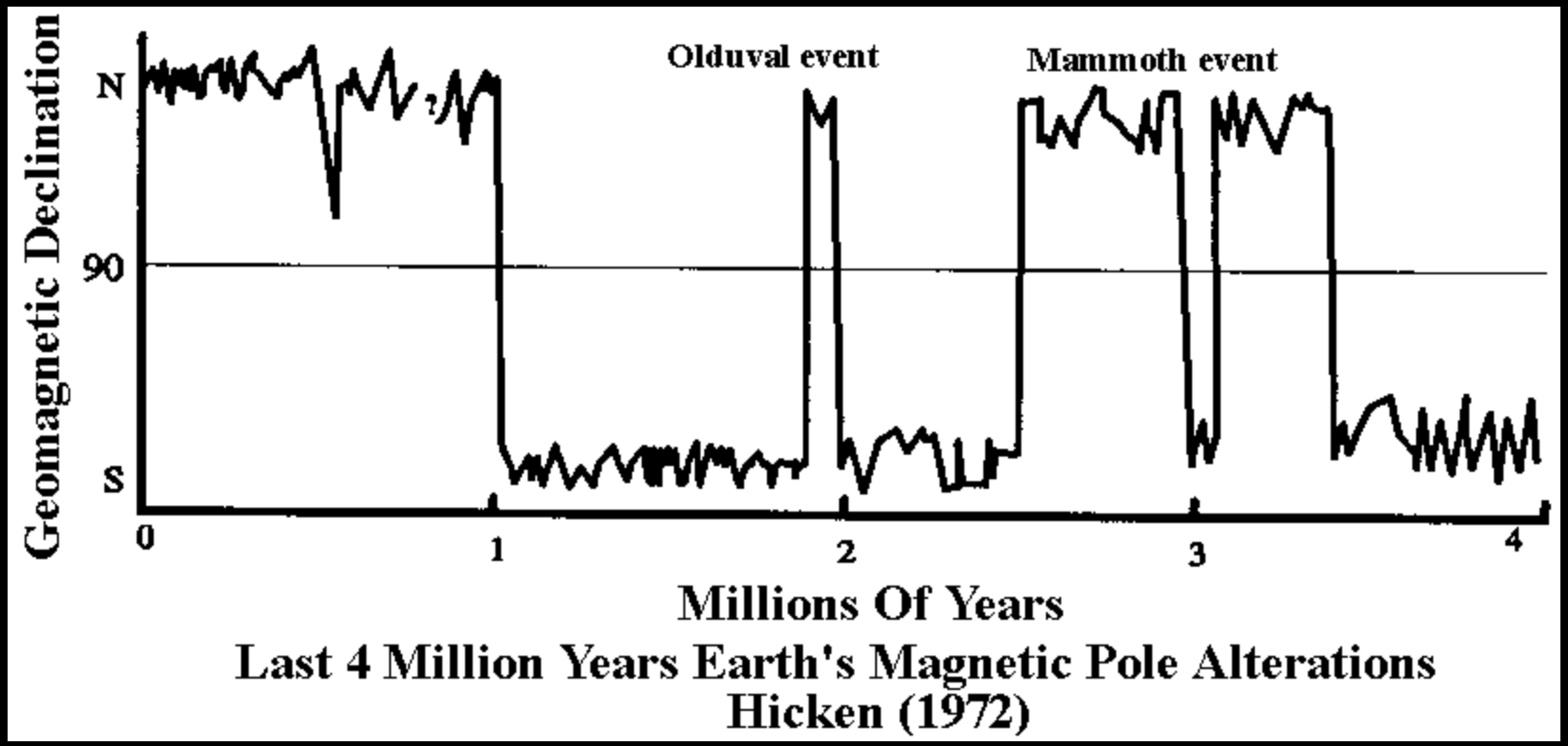
Sailors aboard the American research vessel *Explorer* in 1960 prepare to lower a torpedo-like magnetometer into the water off the Florida Keys. Towed 500 feet behind the ship, the instrument measured the magnetic field emanating from the rocks of the sea floor.

A chart of magnetometer readings taken in the northeast Pacific shows a zebra-like pattern of variations. Scientists at first were baffled by such irregularities, but realized in 1963 that they indicate ancient reversals in the earth's magnetic field that had been recorded in the sea floor as it spread slowly from the ocean ridges.



Wegener, too, had proposed such joinings of the continents, but he had lacked the data—and the sophisticated electronic equipment—to make as impressive a case as Bullard presented with his map, which indicated that the continents had once fit together almost as snugly as the pieces of a jigsaw puzzle.

In early 1965, Tuzo Wilson was in England again, this time at Cam-



Last 4 Million Years Earth's Magnetic Pole Alterations
Hicken (1972)

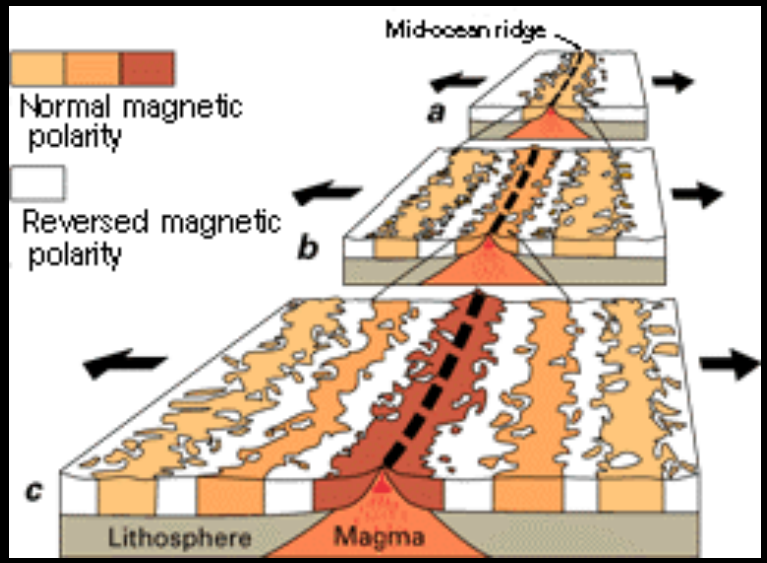

Mid-ocean ridge
Normal magnetic polarity
Reversed magnetic polarity
a
b
c
Lithosphere
Magma

Figure 9.9. Magnetic anomaly profiles collected by the research vessel *Eltanin* became persuasive evidence for seafloor spreading. Walter Pitman at Lamont was especially struck by the bilateral symmetry of traverse number 19. *Eltanin*-19 was singled out for attention; the other profiles were set aside. (Reproduced from Pitman & Heirtzler, 1966: 1165, by arrangement with *Science* copyright 1966 by the AAAS).

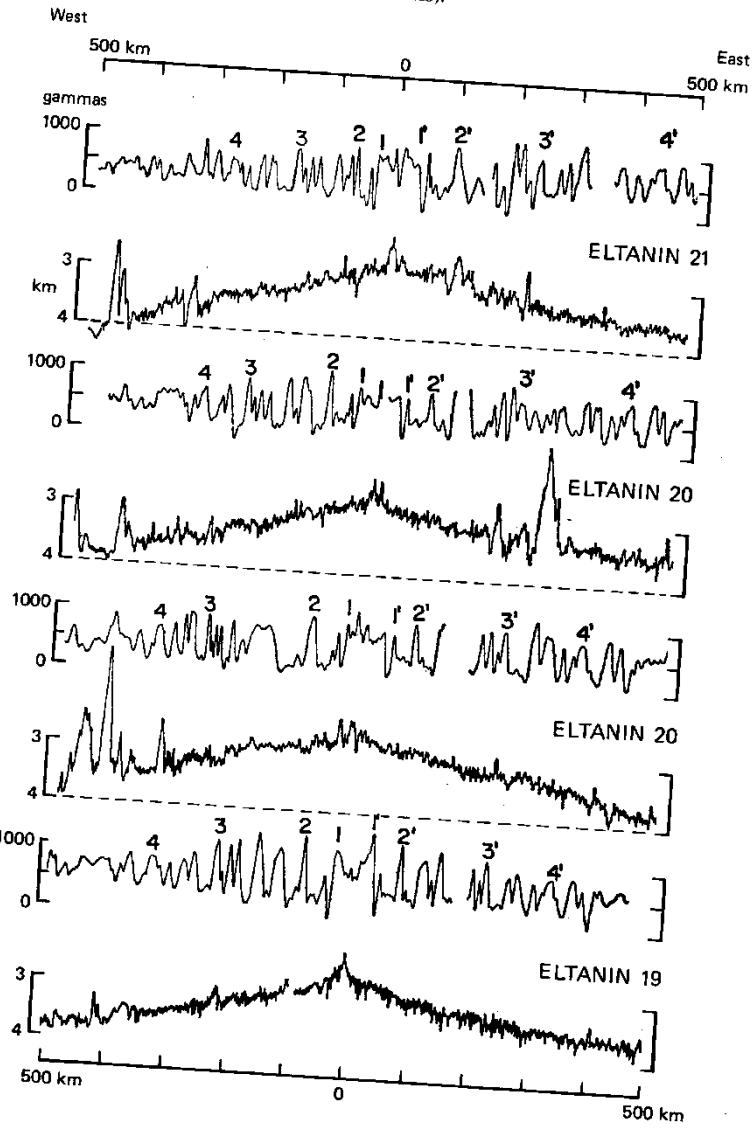
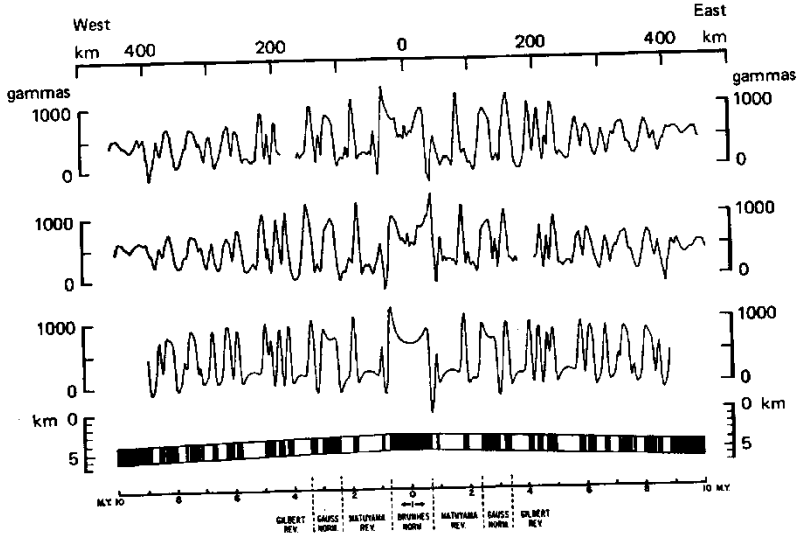
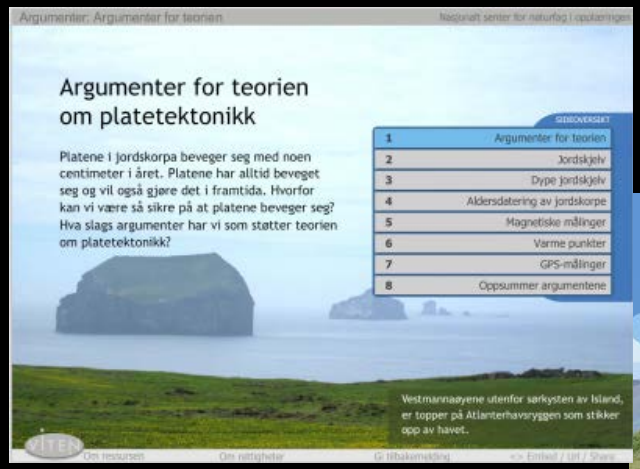


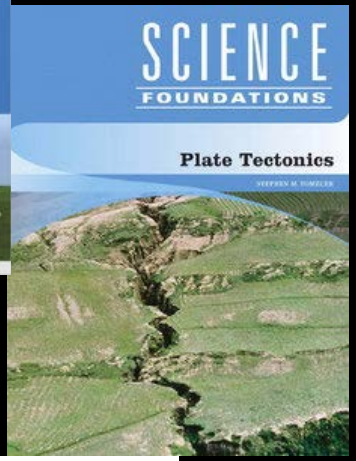
Figure 9.10. The symmetry of *Eltanin*-19 can be seen by comparing the actual profile (center) with its mirror image (upper). Pitman and Heirtzler also calculated an ideal profile (lower) based upon the latest reversal age-scale and uniform spreading. The match between the observed profile and the theoretical one impressed many marine scientists. *Eltanin*-19 soon became the standard illustration for the Vine–Matthews and Vine–Wilson versions of Drift. (Reproduced from Pitman & Heirtzler, 1966: 1166, by arrangement with *Science* copyright 1966 by the AAAS).

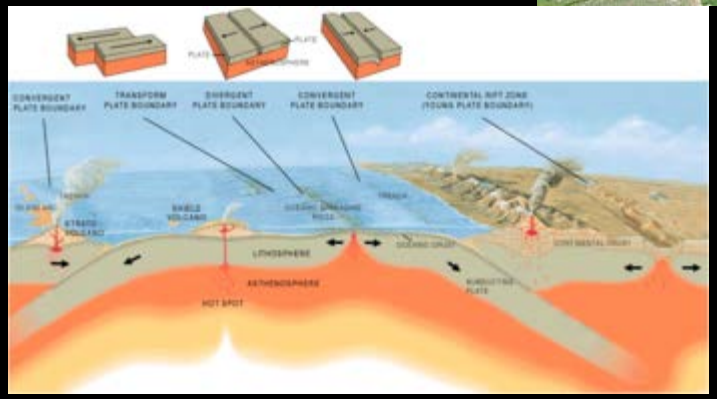


BACK TO NORMAL SCIENCE?

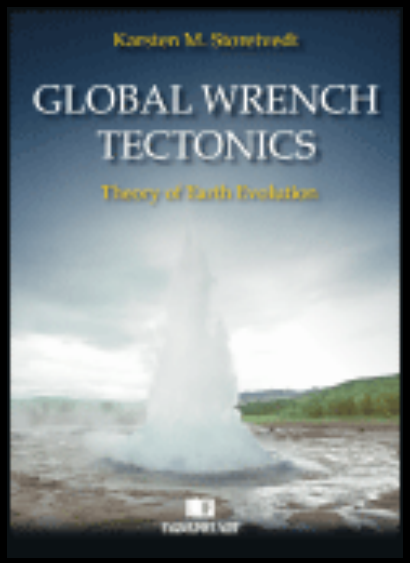
Nowadays: school teaching

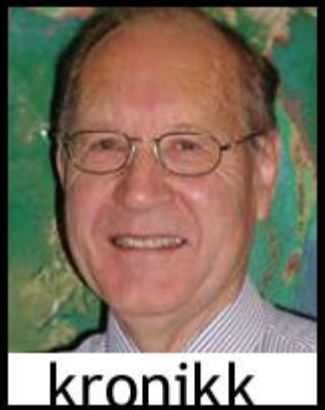






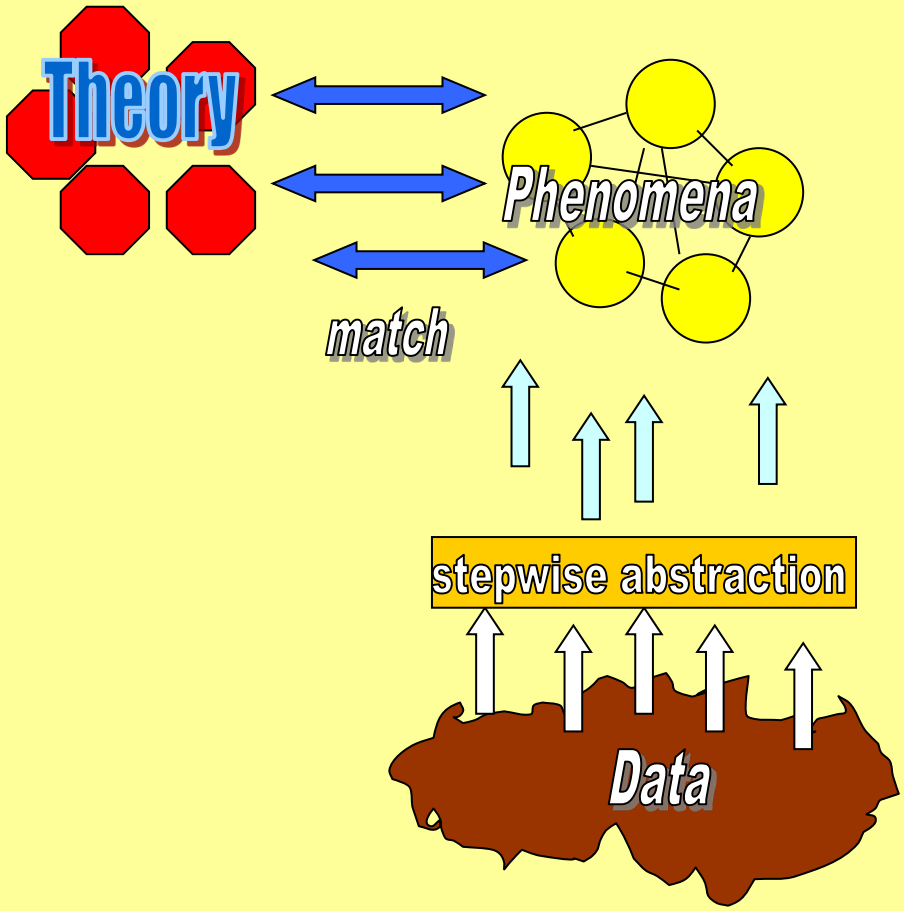
Still some oppostion, e.g. Karsten Storetvedt and his theory of global wrenching.





HOW I CONCEIVE OF SCIENCE:

- Not two, but three basic units: theories, phenomena, and data
- Theories are families of models
- Phenomena are the objects of theories
- Data are the foundation of phenomena
- Not deductive model of statements, but rather structural representation
- Has an ”inductive” step from data to phenomena
- Has a ”deductive” or subsumptive element from theory to phenomena.



ONE LAST QUESTION: ARE YOUR DATA FAKE?

Thank you for your kind attention!

Matthias.kaiser@uib.no