Hist. Geol.: Grundlagen (Klima)

Abb. aus Gehr et al. (1997): CO2 - eine Herausforderung für die Menschheit.-, Springer.

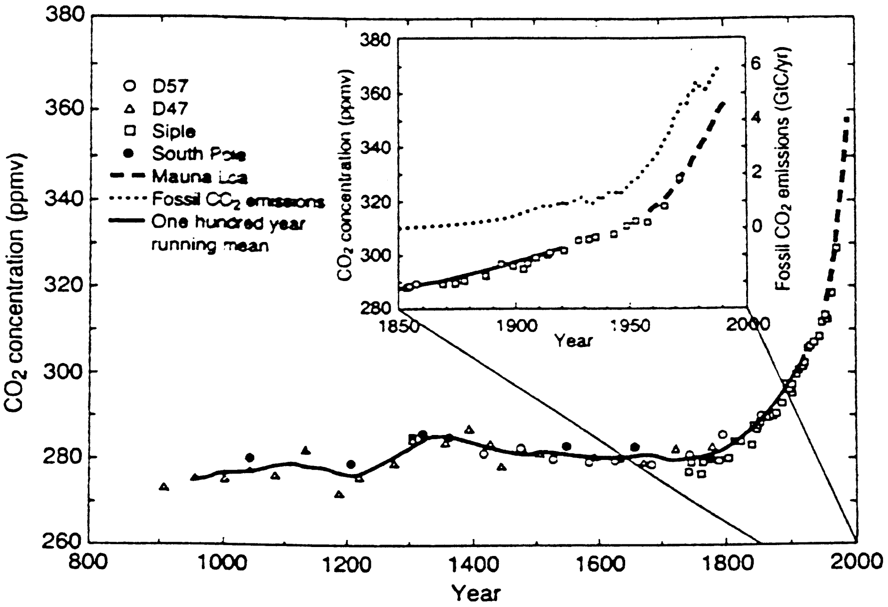
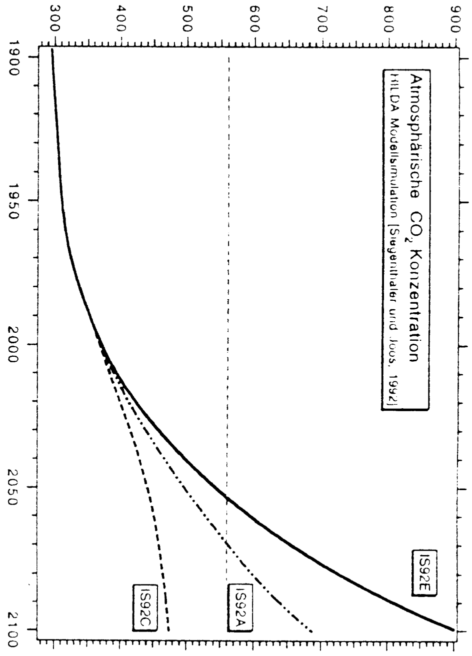


Abb. 1 Verlauf der atmosphärischen CO_2-Konzentration (in ppmv = Anzahl CO_2 Teilchen pro Million Luftteilchen) während der letzten 1000 Jahre [Schimel et al., 1995]. Der Verlauf vor 1959 ist rekonstruiert aus Analysen von Luftbläschen in polaren Eiskernen; nach 1959 direkte Messungen. Im Einschub ist der Zeitraum 1850-2000 genauer dargestellt. Die gepunktete Linie bezeichnet den Verlauf der fossilen CO_2-Emissionen.



Szenarien des IPCC

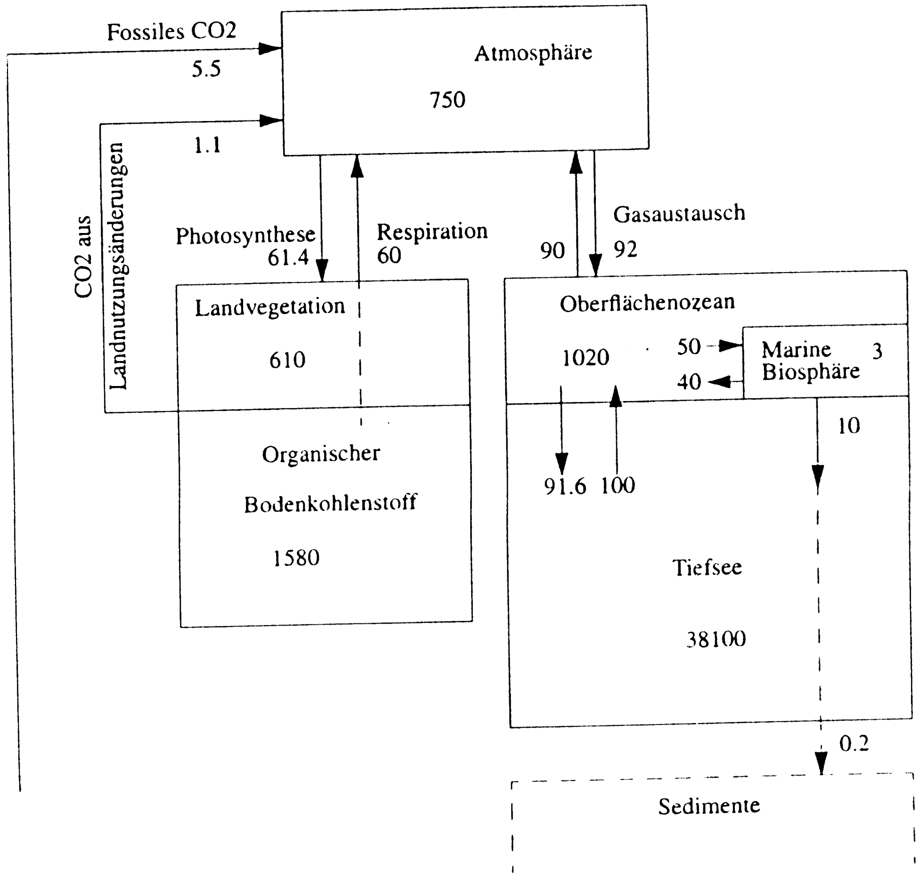
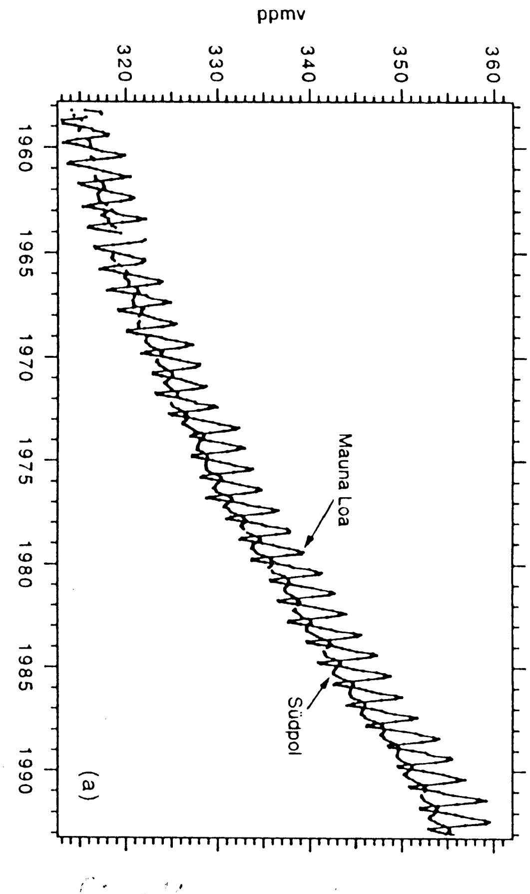
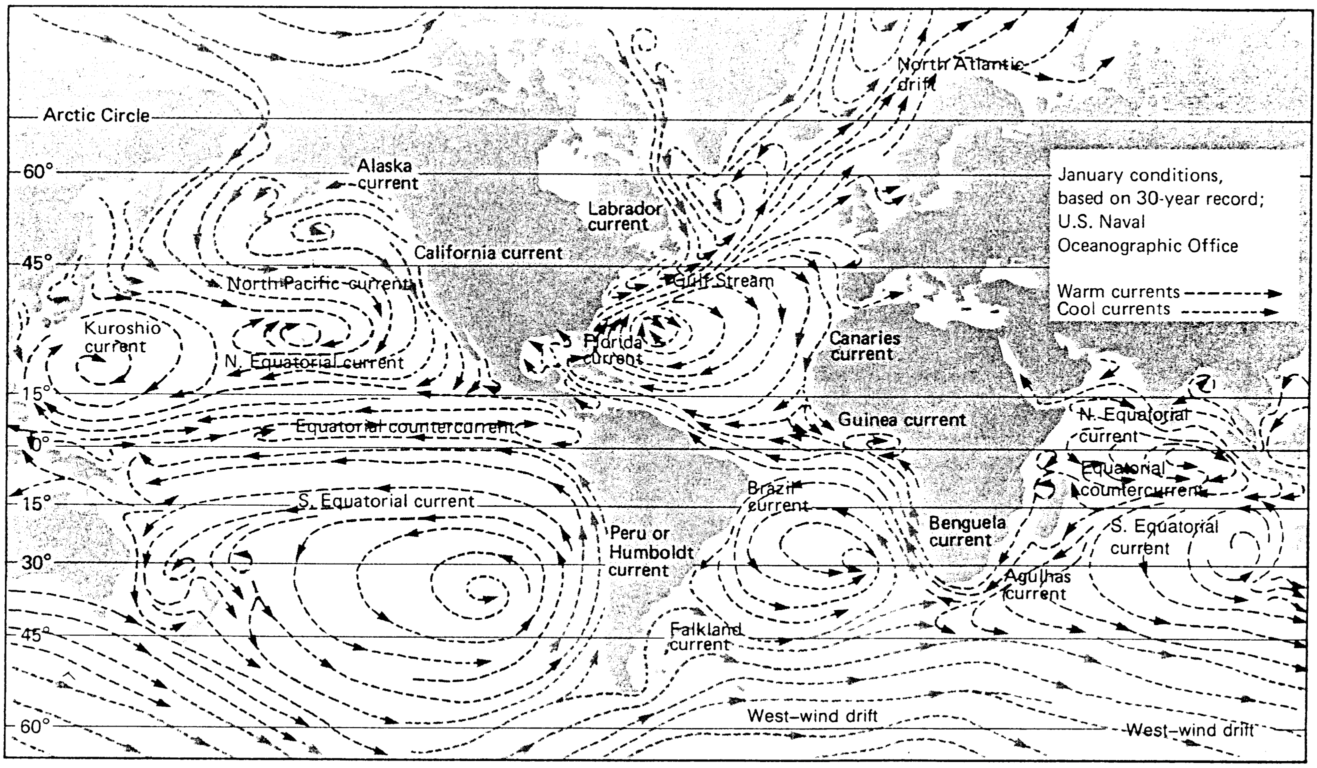


Abb.3 Vereinfachtes Schema der globalen Kohlenstoffspeicher, die auf Zeitskalen von bis zu einigen hundert Jahren mit der Atmosphäre CO_2 austauschen. Die Zahlenwerte bezeichnen den Kohlenstoffinhalt (in GtC) resp. die Kohlenstoffflüsse (in GtC/a).

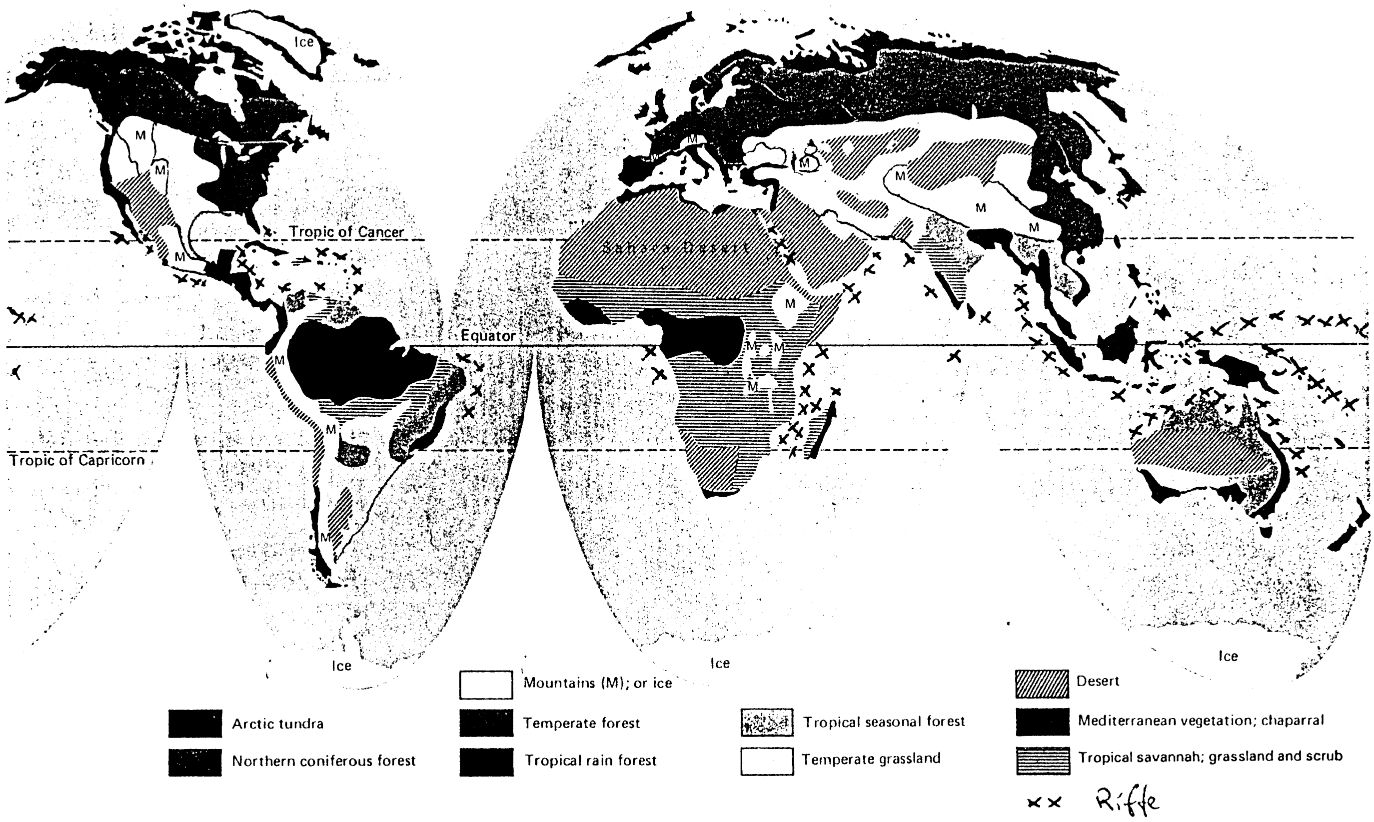


[illegible]

Hist. Geol: Grundlagen (Klima)



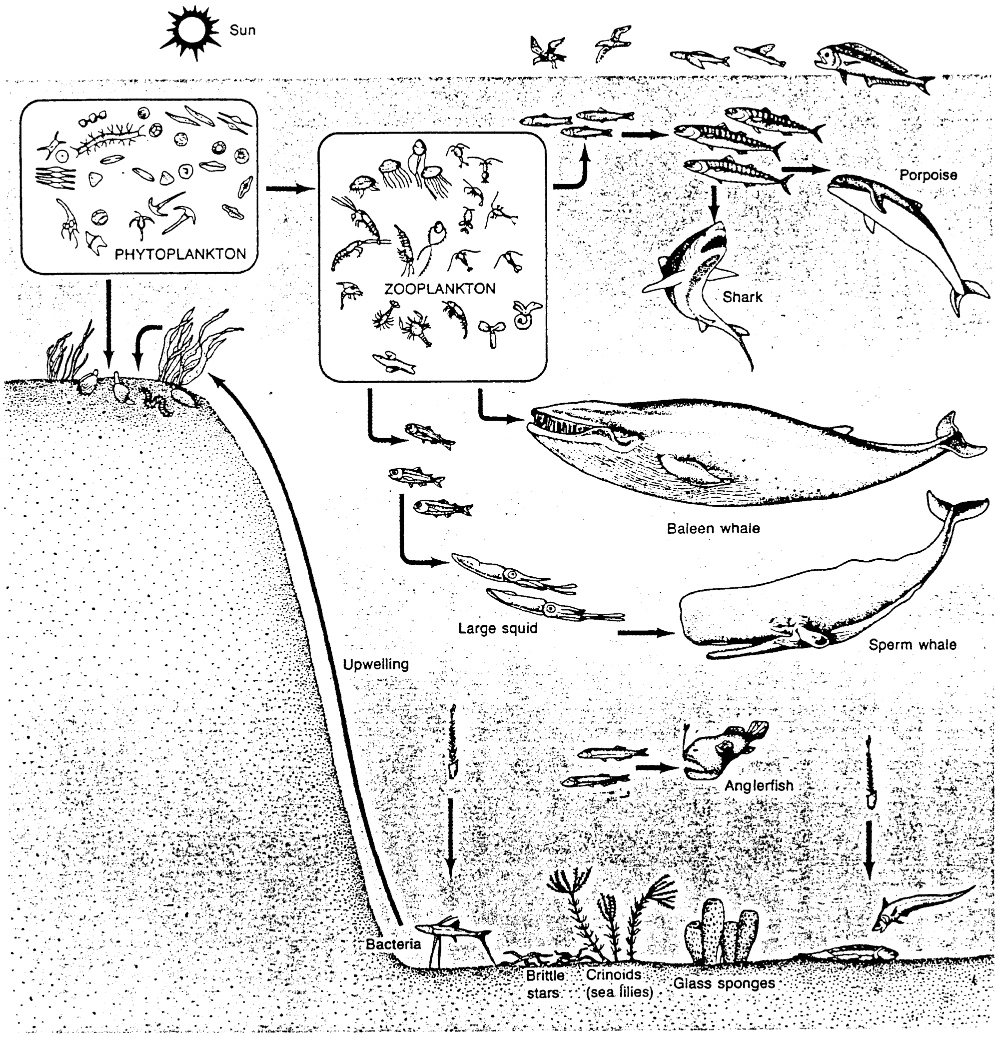
Major surface currents of the ocean. Note that large gyres north of the equator move clockwise, while those south of the equator move counterclockwise. (*After P. R. Ehrlich, A. H. Ehrlich, and J. P. Holdren, Ecoscience: Population, Resources, and Environment, W. H. Freeman and Company, New York, 1977.*)



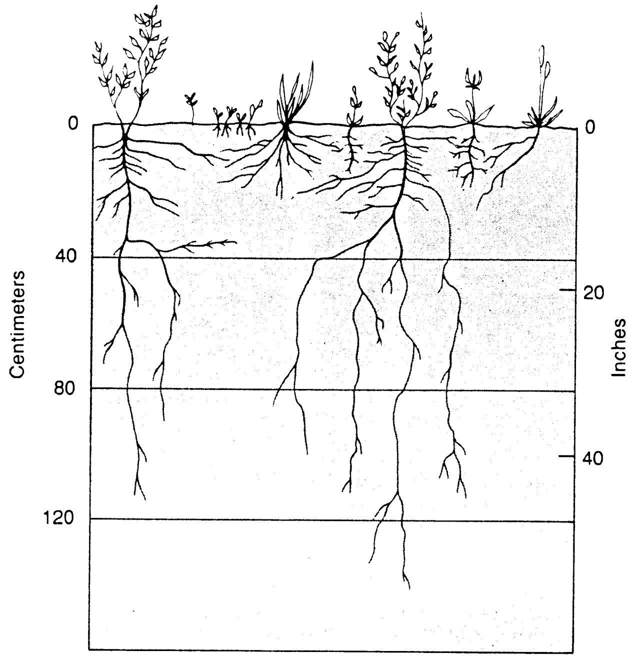
×× Riffe

②

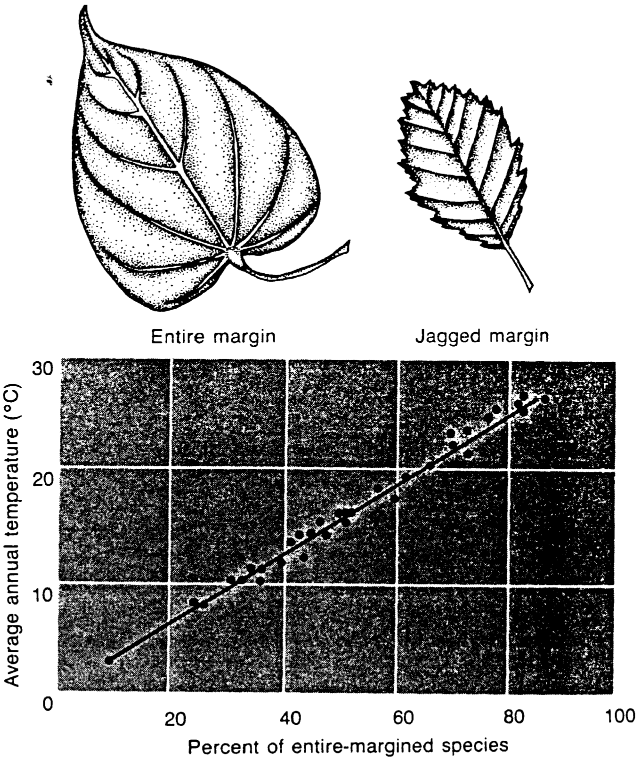
Hist. Geol.
Grundlagen
(Ökolo[illegible])



The food web in the ocean (the various forms of life are not drawn to scale). Phytoplankton occupy the photic zone of the ocean, and thus most zooplankton, which feed on phytoplankton, also live here. On continental shelves, especially near the shore, bottom-dwelling plants also contribute food to the marine ecosystem. Most species of large carnivores are fishes. Whales are warm-blooded mammals that include carnivorous porpoises and sperm whales, which feed on large animals, as well as baleen whales, which strain tiny zooplankton from the water. As the amount of plant material diminishes with depth, the abundance of animal life diminishes as well. A few suspension feeders, such as sponges and crinoids (sea lilies), live in the deep seafloor, but most herbivores there are deposit feeders. Bacteria in the deep sea turn dead organic matter into nutrients that upwelling currents carry to the surface for use by phytoplankton and other photosynthetic life.

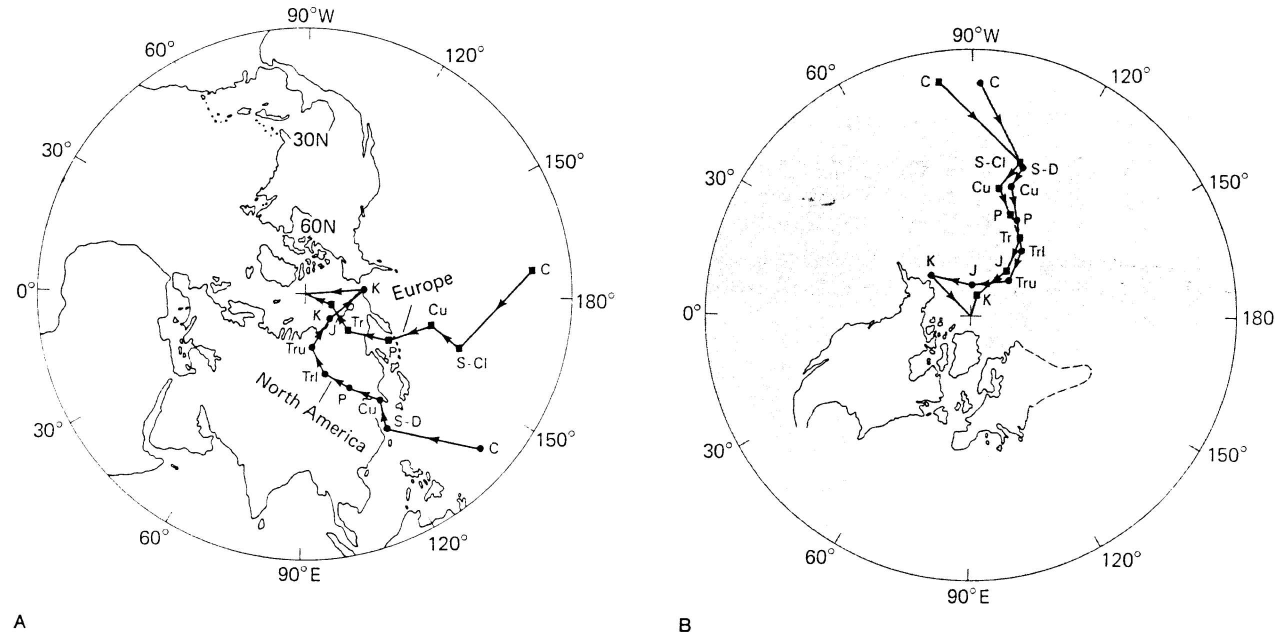


Differences in the niches of coexisting species of plants. The roots of different species occupy different depth zones of the soil and thus avoid competing for water and nutrients. (*After H. Walter, Vegetation of the Earth in Relation to Climate and Eco-Physiological Conditions, Springer-Verlag, Stuttgart, 1973.*)

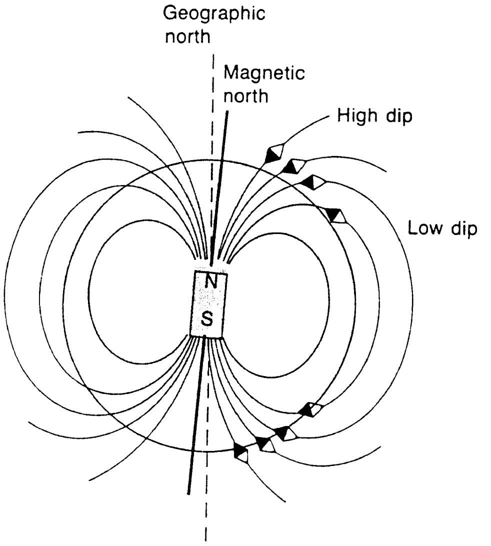


Relation between climate and leaf shapes of flowering plants. In the modern world there is a close correlation between the average annual temperature of a region and the percentage of plant species with entire (or smooth) margins. (*After J. A. Wolfe, American Scientist, 66:994–1003, 1978.*)

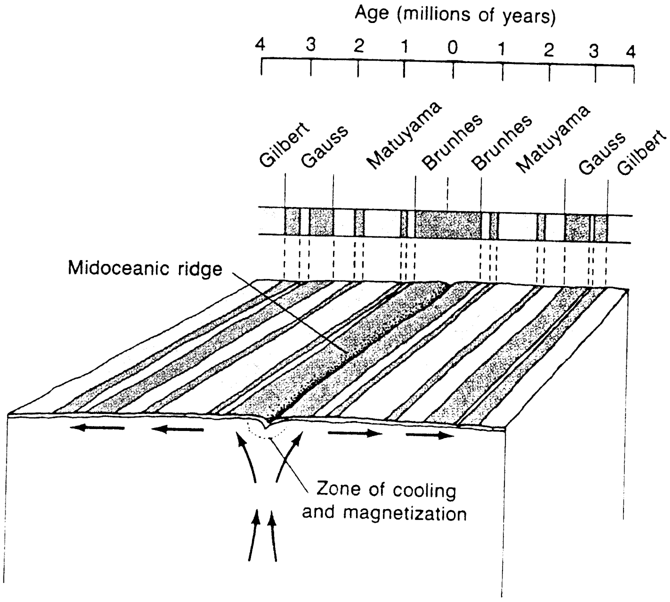
Hist. Geol.: Grundlagen (Paläomagnetik)



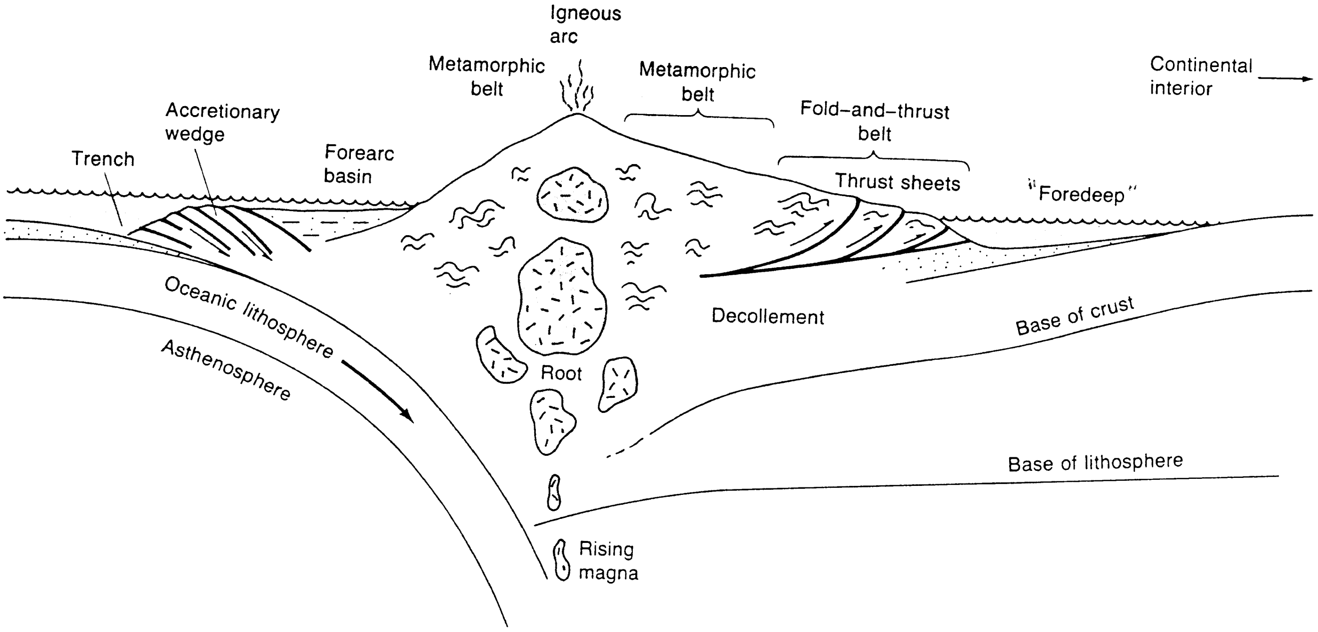
Apparent polar-wander paths for North America *(circles)* and Europe *(squares)*. A. Plot of polar-wander paths based on the assumption that the continents have remained in their present positions. B. Plot for North America and Europe juxtaposed, as postulated for Paleozoic time by Wegener and his followers. Here the Paleozoic and Mesozoic apparent polar-wander paths for the two continents nearly coincide, suggesting that the continents were united during the Paleozoic Era. The time-rock units represented are Cretaceous *(K)*, Triassic *(Tr)*, Upper Triassic *(Tru)*, Lower Triassic *(Trl)*, Permian *(P)*, Upper Carboniferous *(Cu)*, Siluro-Devonian *(S-D)*, Silurian to Lower Carboniferous *(S-Cl)*, and Cambrian *(C)*. *(After M. W. McElhinny, Paleomagnetism and Plate Tectonics, Cambridge University Press, London, 1973.)*



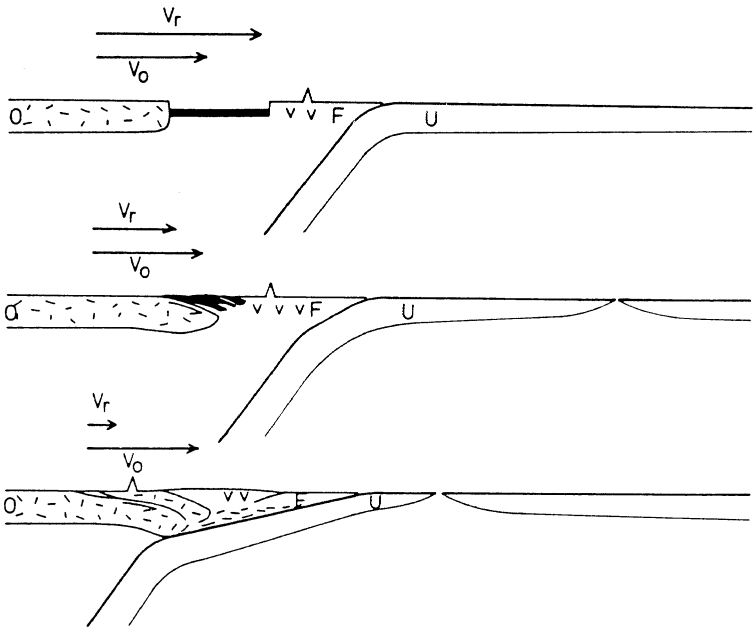
Diagrammatic illustration of the structure of the earth's magnetic field. The core has north and south poles and thus behaves like a bar magnet. The north-south axis has a declination of 15° from the earth's north-south geographic axis. Curved lines represent magnetic lines of force. These lines of force have high dips near the poles and low dips near the equator.



Magnetic anomaly patterns of the seafloor fit the prediction that they represent magnetic reversals. Above is the time scale for known magnetic reversals of the past 4 million years. The labels (Gilbert through Brunhes) represent intervals that are, for the most part, characterized by either normal or reversed polarity, which have been dated by identifying the polarity of terrestrial rocks whose ages are known. The relative widths of these intervals are remarkably similar to those of the magnetic-anomaly stripes on either side of a midocean ridge. Assuming that the rate of seafloor spreading has not varied greatly during the past 4 million years, this correspondence is exactly what we would expect if the striping resulted from magnetic reversals. *(After A. Cox et al., Scientific American, February 1967.)*

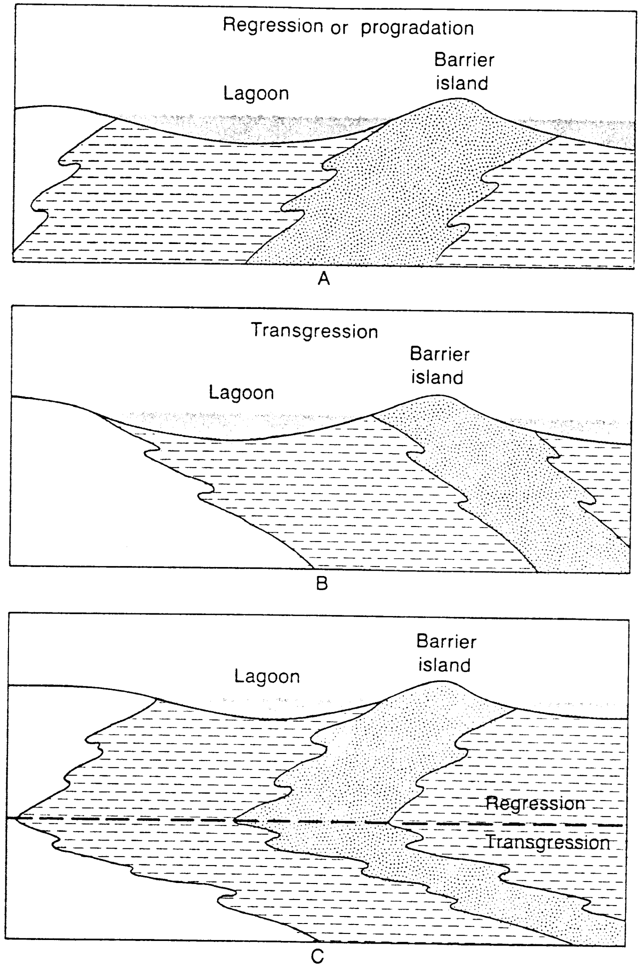


The configuration of an idealized mountain chain forming where an oceanic plate is being subducted beneath the edge of a continent. This cross section illustrates the general symmetry of the mountain chain. Metamorphism dies out both toward the sea and toward the land from the central igneous arc, and beyond the metamorphic belt, in the direction of the continental interior, is a fold-and-thrust belt. Beyond the inland fold-and-thrust belt, the crust is warped downward to form a foredeep, where sediments from the mountain system accumulate.

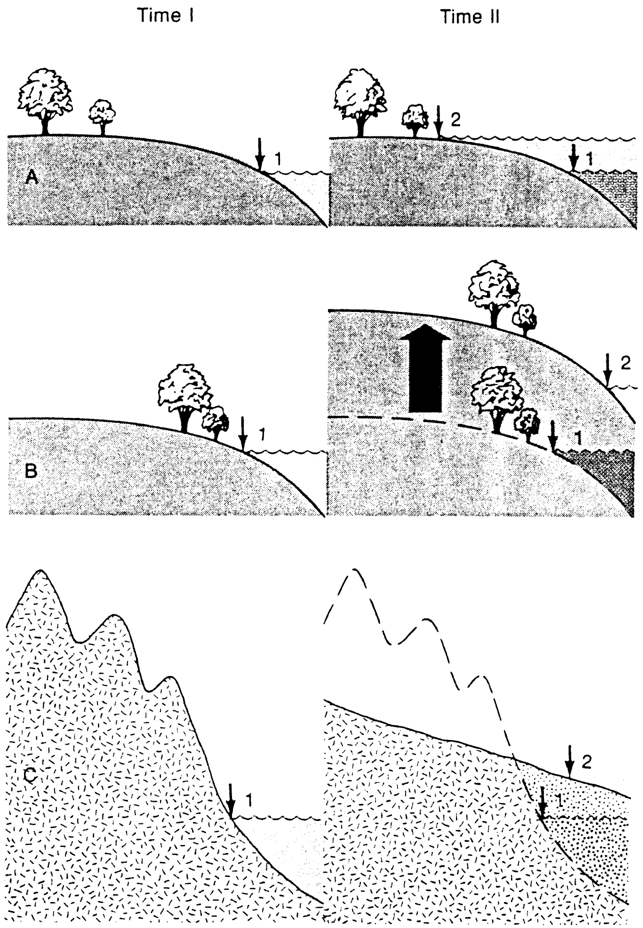


Possible sequence of events during a Wilson cycle as progressively younger oceanic crust is subducted. A backarc basin is first opened and then closed (Dewey, 1980).

Hist. Geol.: Grundlagen (Trans/Regression)



Correlation based on a stratigraphic pattern in which a regressive depositional sequence follows a transgressive sequence. *A.* The pattern of a regressive (progradational) sequence. *B.* The pattern of a transgressive sequence. *C.* When a regression follows a transgression, the points of maximum transgression of various facies can be connected to form a line of correlation, as indicated by the broken line in the diagram. A similar line can be constructed for a stratigraphic pattern in which a transgression follows a regression.



Diagrammatic cross sections of shorelines showing that a rise in sea level does not necessarily result in a transgression. In each of the three pairs of diagrams, the initial and final positions of sea level are numbered 1 and 2. *A.* The land remains unchanged, and a rise in sea level causes a transgression. *B.* A rise in sea level is accompanied by regression rather than by transgression because the land rises tectonically (*heavy arrow*) more than does sea level. *C.* A rise in sea level is accompanied by regression (progradation) rather than by transgression because sediment eroded from nearby highlands pushes the shoreline seaward.

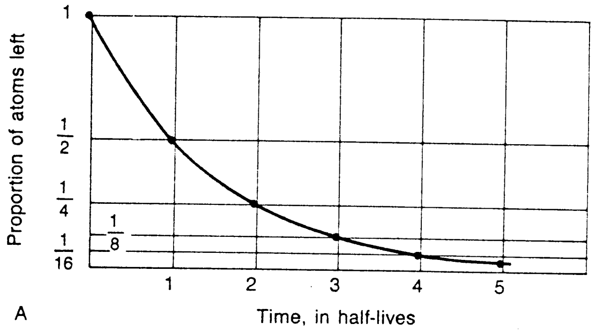
Hist. Geol: Gradualismus
(Radiometrische Datierung und Speziation)

3

Properties of some radiometric isotopes that are commonly used to date rocks

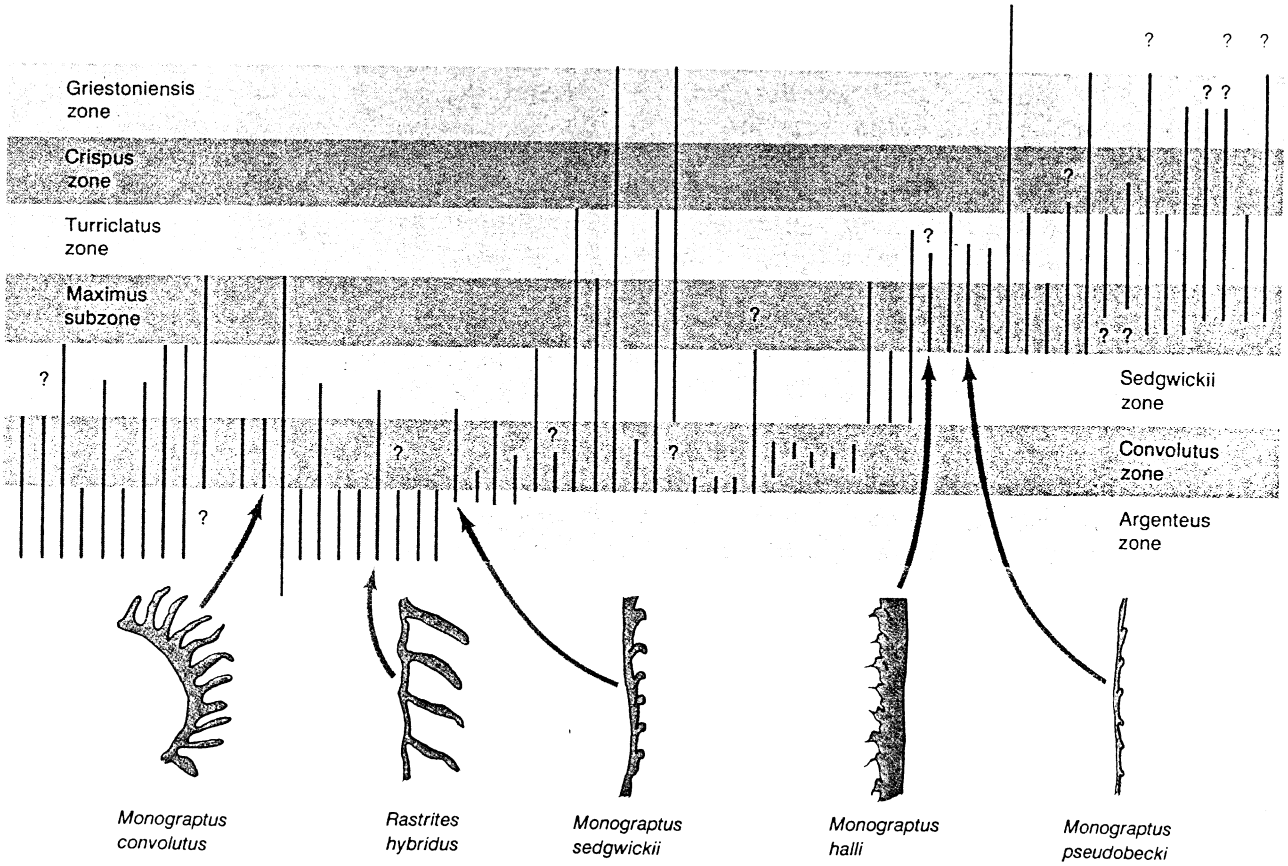
The number after each element name signifies the atomic weight of that element and serves to identify the isotope. Carbon 14, which has a very short half-life (that is, a high rate of decay), is used for dating materials younger than about 70,000 years. The other radioactive isotopes are employed for dating much older rocks.

Radioactive isotope	Approximate half-life, years	Product of decay
Rubidium 87	48.6 billion	Strontium 87
Thorium 232	14.0 billion	Lead 208
Potassium 40	1.3 billion	Argon 40
Uranium 238	4.5 billion	Lead 206
Uranium 235	0.7 billion	Lead 207
Carbon 14	5730	Nitrogen 14

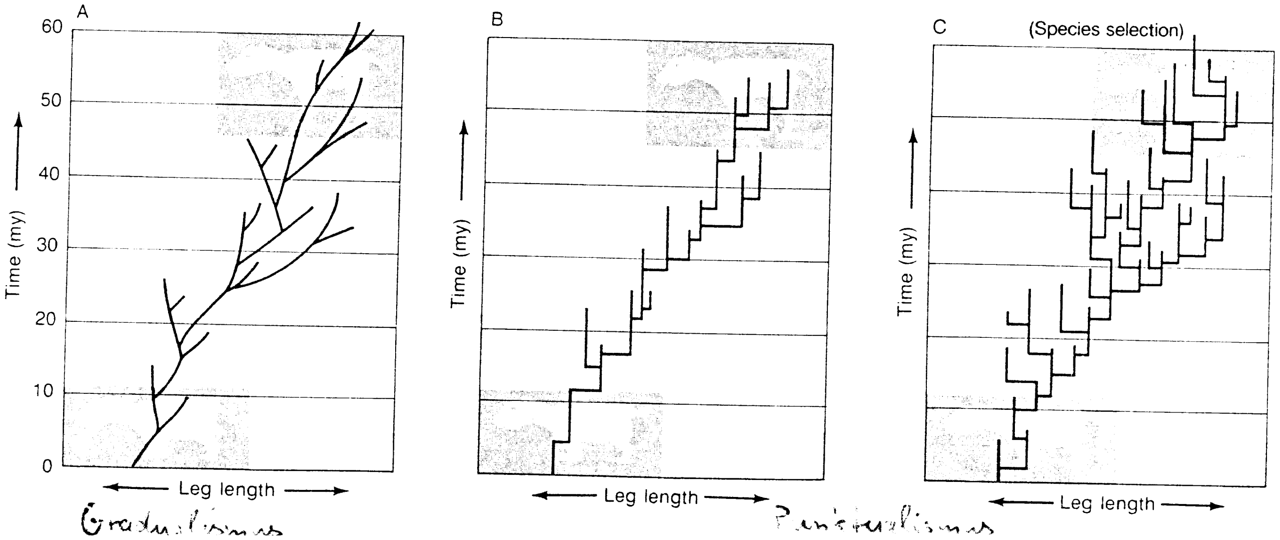


Graphs illustrating the pattern by which atoms are lost through radioactive decay. When plotted on a standard arithmetic scale (*A*), the number of atoms can be seen to decrease more slowly with each successive interval of time.

Graptolites: Index Fossils of the Paleozoic



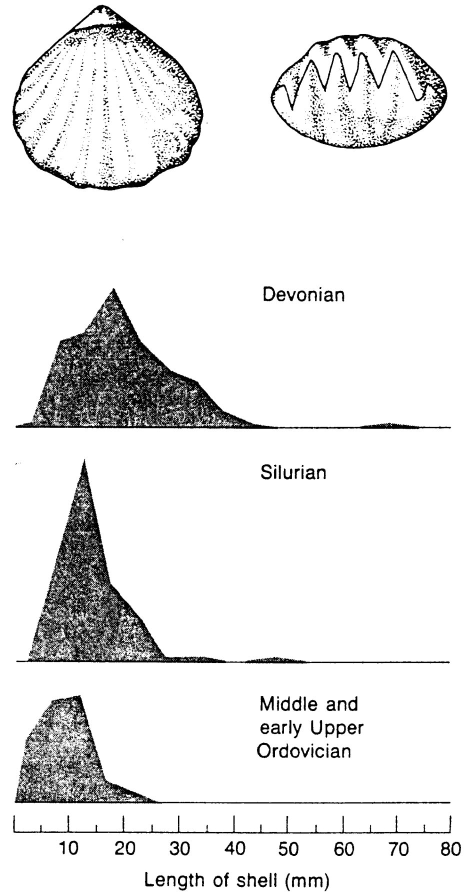
Unterer Silur



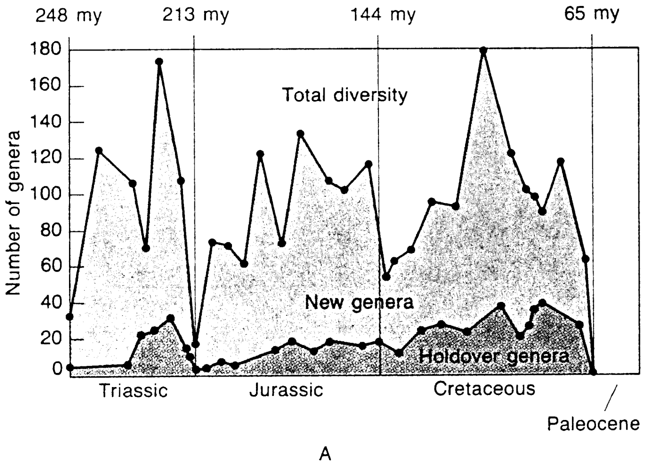
Gradualismus

Punktualismus

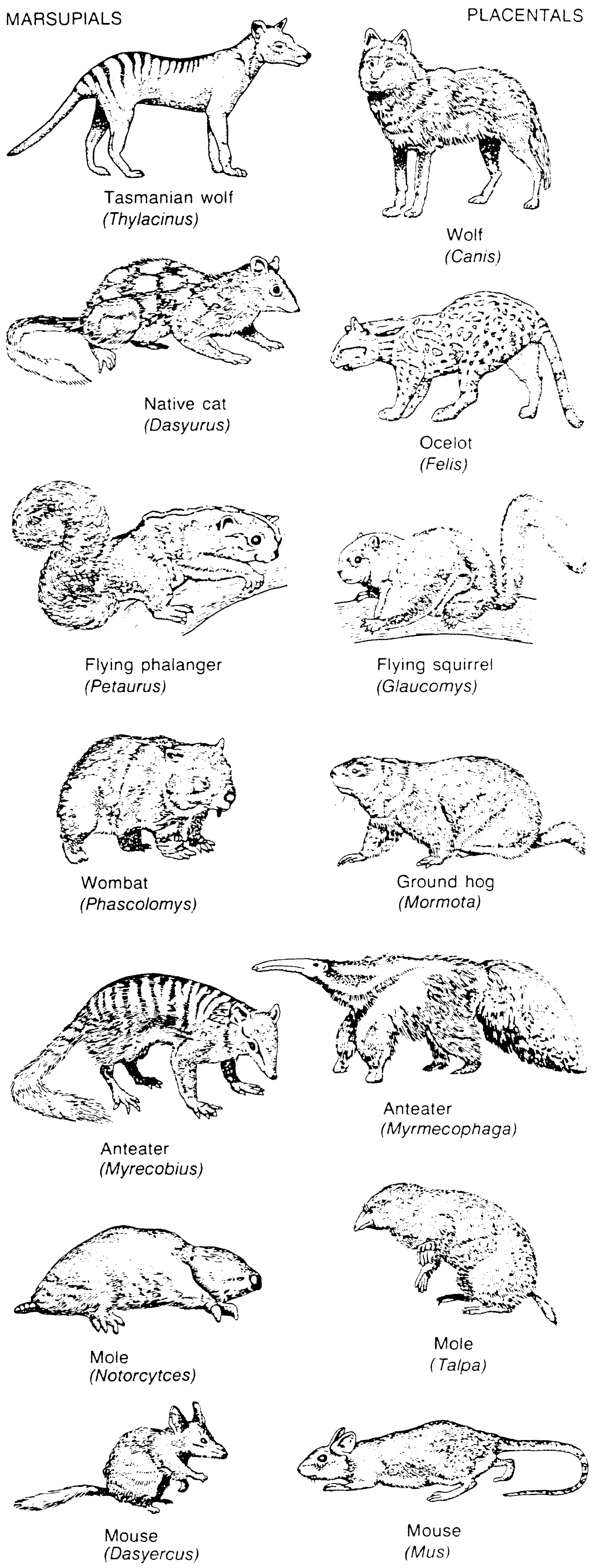
Hist. Geol.: Grundlagen (evol. Größenzunahme, Massensterben, Konvergenz)



Cope's rule, as illustrated by an order of brachiopods (the Rhynchonellida). In mid-Ordovician time, this order — of which a typical member is shown in two views — included few species with shells longer than 25 millimeters (~1 inch). During the Devonian Period, many small species were present, but the maximum size had increased markedly, as had the average size. *(After S. M. Stanley, Evolution, 27:1–26, 1973.)*



The appearance and disappearance of ammonoid genera through time. Ammonoids were coiled mollusks related to squids and octopuses but possessed coiled external shells (B). They became extinct with the dinosaurs at the end of the Cretaceous Period. As this diagram shows, the ammonoids experienced a high rate of turnover of genera throughout their history. Data plotted for each stage of the Mesozoic Era show that there are few "holdover genera" from one stage to the next. Thus, most genera of each stage are ones that formed during the corresponding age. *(After W. J. Kennedy, in A. Hallam [ed.], Patterns of Evolution. Elsevier, Amsterdam, 1977, pp. 251–304.)*



Evolutionary convergence between marsupial mammals of Australia and nonmarsupial mammals of other continents. Each of the marsupials is more closely related to a kangaroo than to its counterpart in the other column. *(After G. G. Simpson and W. S. Beck, Life, Harcourt, Brace & World, Inc., New York, 1965.)*

(7a)

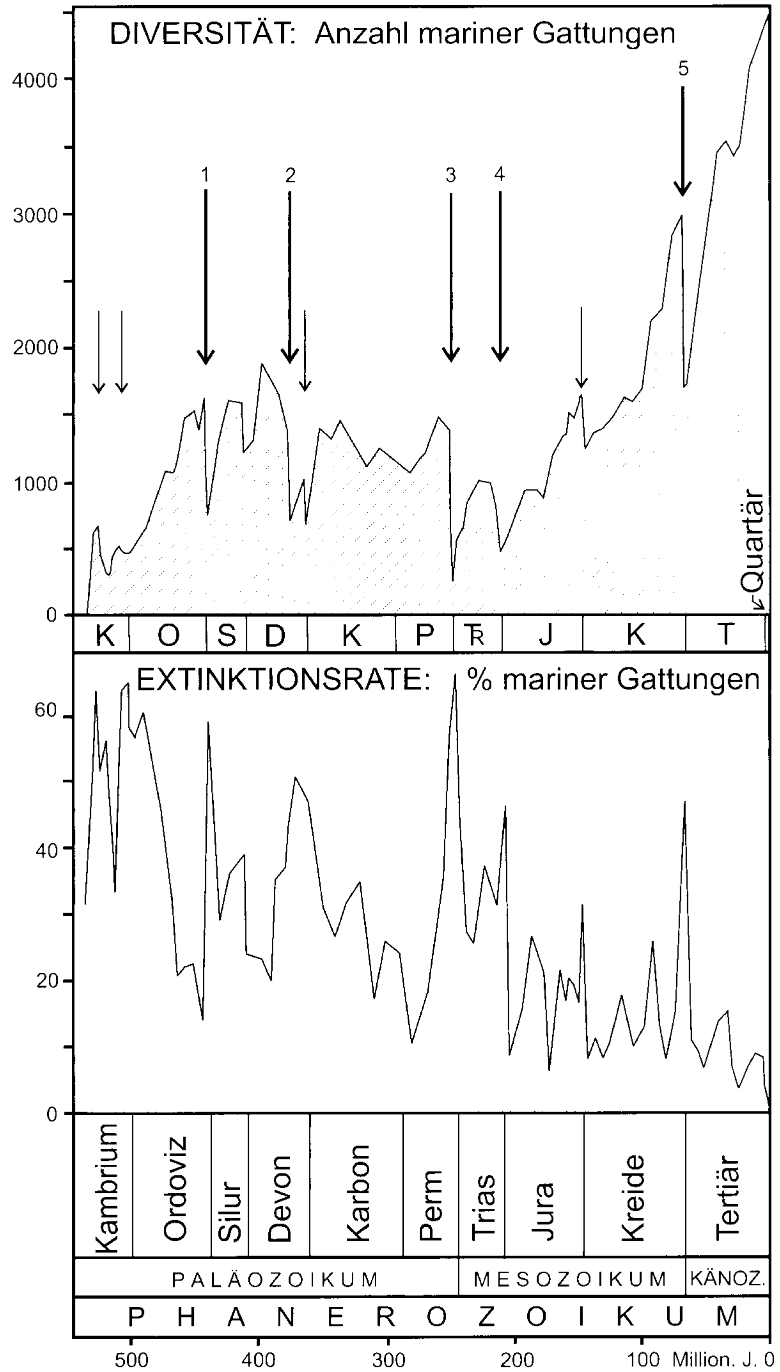


Abb. 1. Diversität und Extinktionsrate mariner Tiergattungen im Phanerozoikum. Im oberen Diagramm sind die „Großen Fünf" sowie weitere gravierende Faunenschnitte durch Pfeile markiert.

Muster des Faunenkrisen.

Abb. aus Walliser, O.H. (2003): Sterben und Neubeginn im Spielel der Paläofaunen.- Museo, 19, 60-69, Heilbronn.

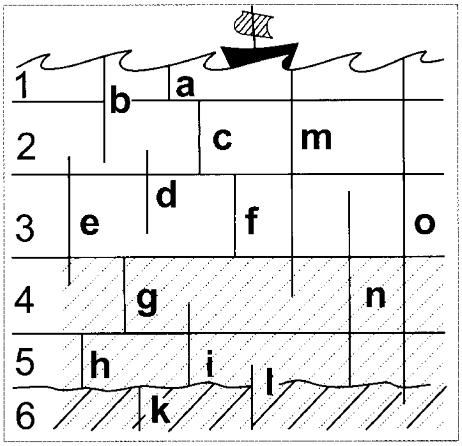


Abb. 4. Schema der vertikalen Gliederung eines Meeresbereiches in Biozönosen. 6: Biozönose mit Endobenthos in der obersten Sedimentschicht. 5: Biozönose des Epibenthos, also der auf dem Meeresboden lebenden Organismen. Das Nekton, dies sind aktiv schwimmende Tiere, sowie das passiv im Wasser schwebende Plankton kommen in allen Bereichen über dem Meeresboden vor. 1: Produktive Zone des Phytoplanktons. a – o: Beispiele für verschiedene Lebensbereiche von Organismen. Als Fallbeispiel wird angenommen, dass die Biozönosen 4 – 6 durch das Eindringen von sauerstoffarmem Wasser vernichtet werden. Nähere Erläuterungen im Text.

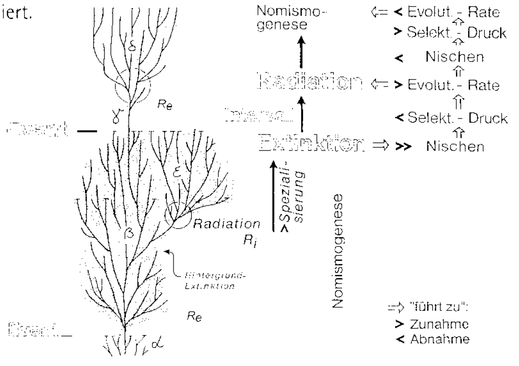
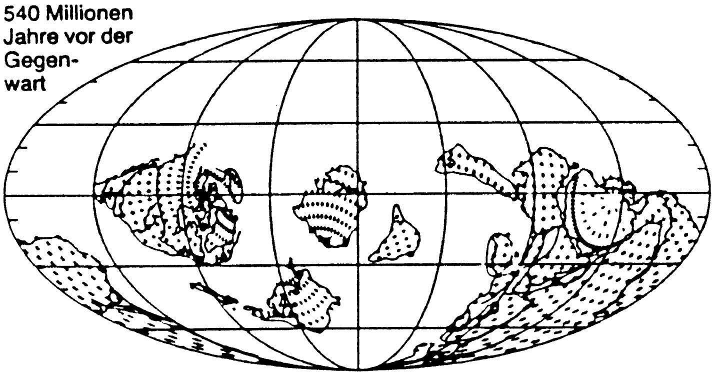


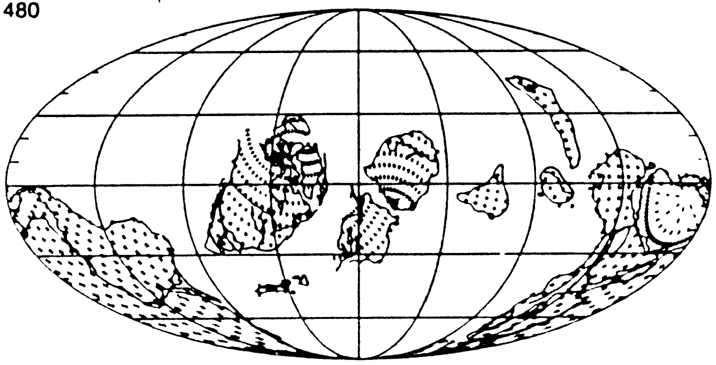
Abb. 3. Die Auswirkung globaler Faunenschnitte auf die Stammesgeschichte. Schematische Darstellung. Re: Radiation nach einem Extinktions-Event, Ri: Radiation nach einer biologischen Innovation.

Hist. Geol.: Übersicht über Plattenbewegungen

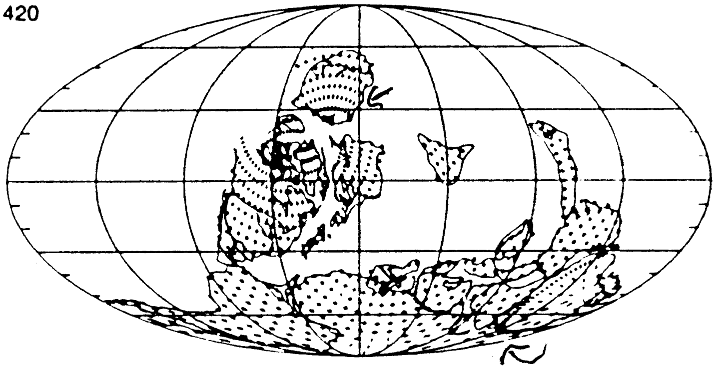
Kambrium
540 Millionen
Jahre vor der
Gegen-
wart



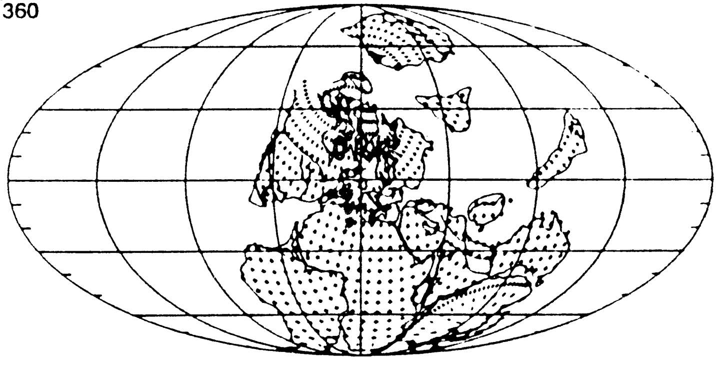
Ordovizium
480



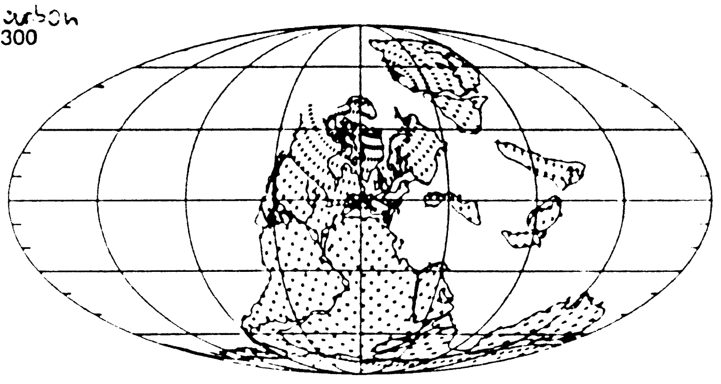
Silur
420



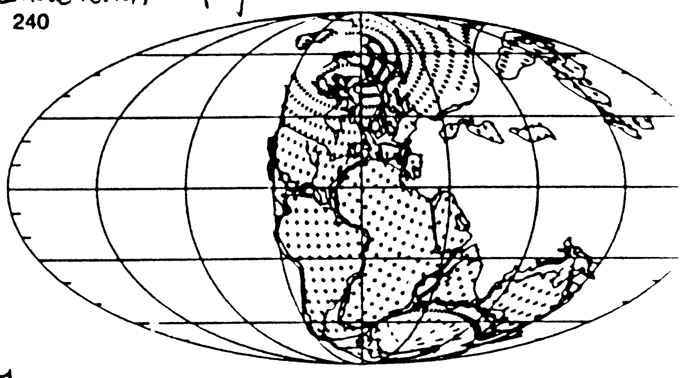
Devon
360



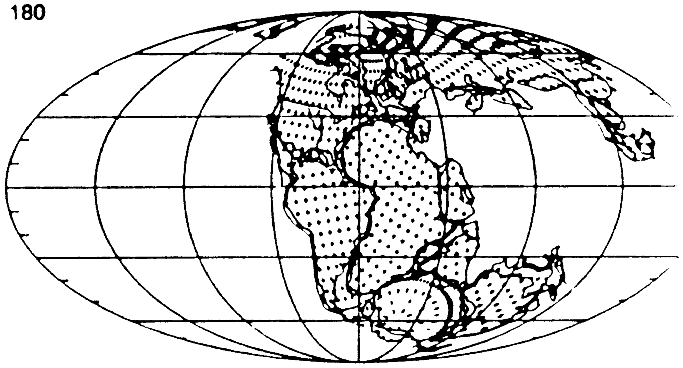
Karbon
300



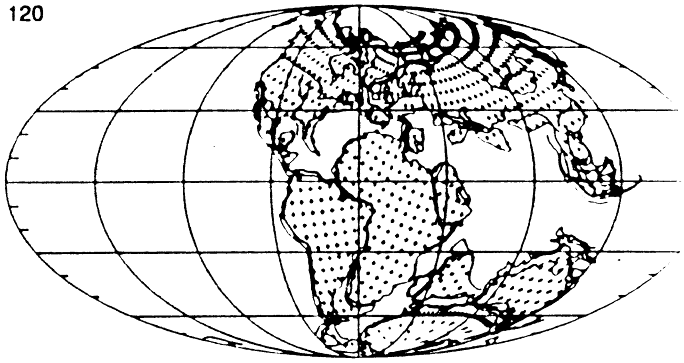
Ende Perm / Anfang Trias
240



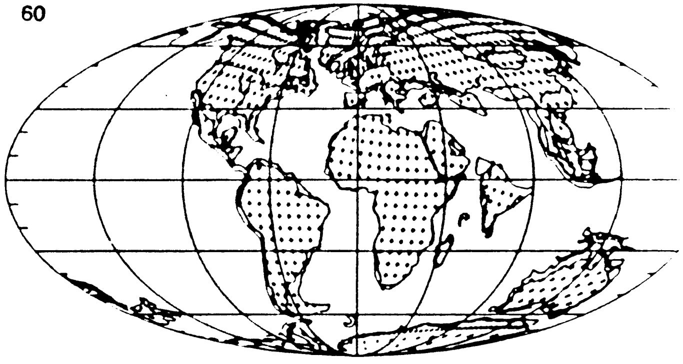
M. Jura
180



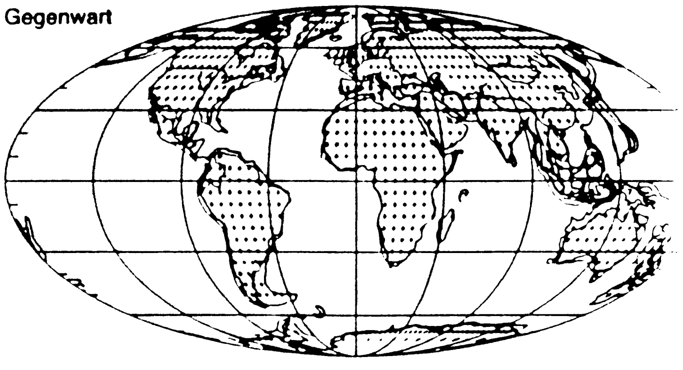
U. Kreide
120



Alttertiär
60



Gegenwart



Hut Geol.: Zeittafel

(9)

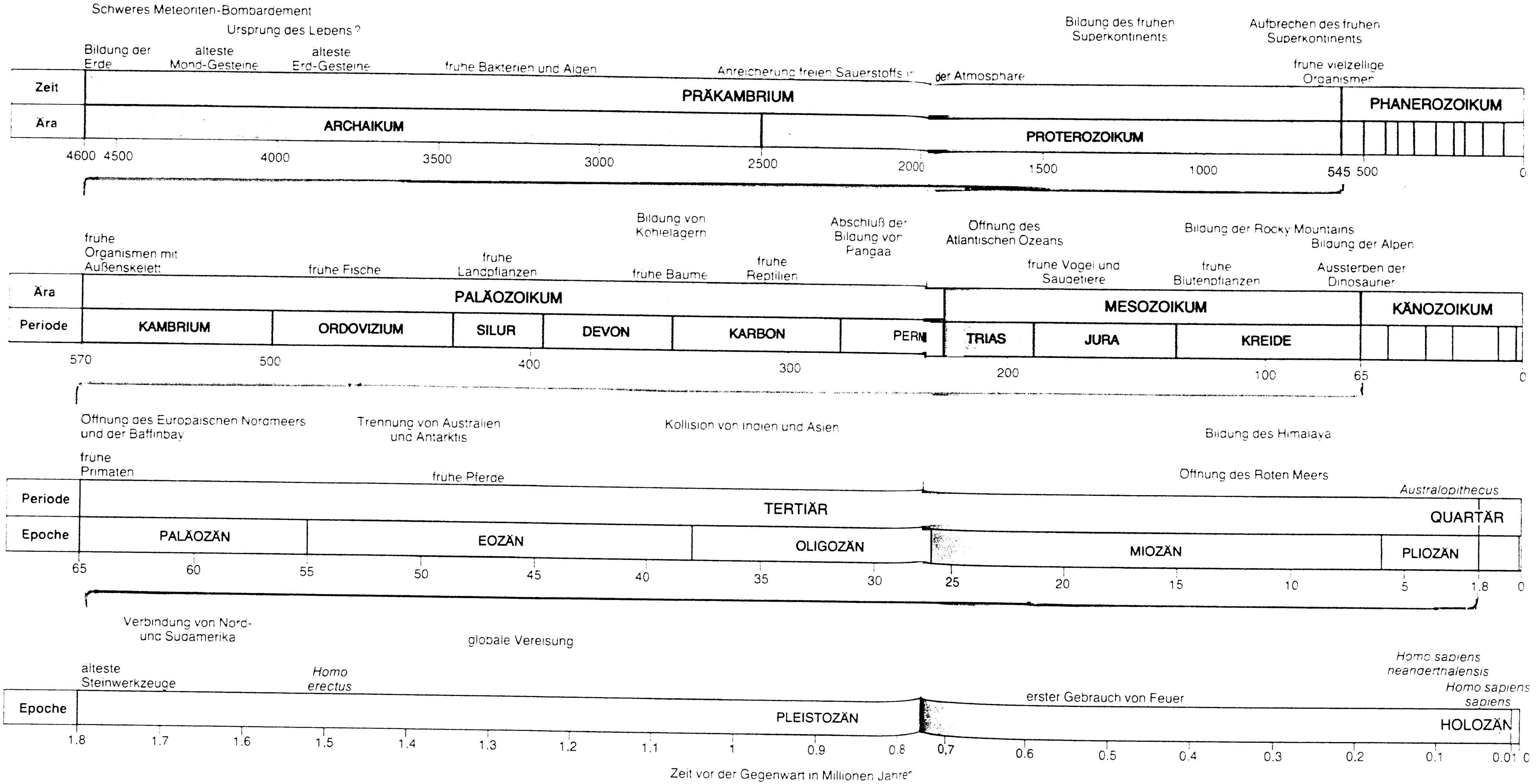


Bild 2: Die geologische Zeittafel, die ursprünglich von Naturwissenschaftlern des 19. Jahrhunderts nur auf Grund von Fossilienbefunden aufgestellt wurde, ist inzwischen mit modernen radiometrischen Methoden geeicht. In dieser Darstellung zeigt die oberste Linie die ganze Reichweite der geologischen Zeit von der Entstehung der Erde vor etwa 4,6 Milliarden Jahren bis zur Gegenwart. Die verhältnismäßig kurze Zeitspanne des Phanerozoikums, dessen Gesteine Fossilien mit Hartteilen in großer Zahl enthalten, ist in der zweiten Linie gespreizt. Die folgenden Balken geben immer kürzere Zeitabschnitte jeweils vergrößert wieder. Die drei Zeitalter des Phanerozoikums hat man in elf Perioden unterteilt; die Periode Tertiär gliedert sich wiederum in fünf und die Periode Quartär in zwei Epochen. Die Eichung der geologischen Uhr durch radioaktive Datierung wird ständig verfeinert. So analysierte kürzlich eine internationale Wissenschaftlergruppe unter dem französischen Geochronologen G. S. Odin das radiometrische Datenmaterial neu und folgerte, daß der Beginn des Kambriums bereits vor 540 bis 520 Millionen Jahren anzusetzen sei.