Hist. Geol: Archaikum
Grünstein-Gürtel

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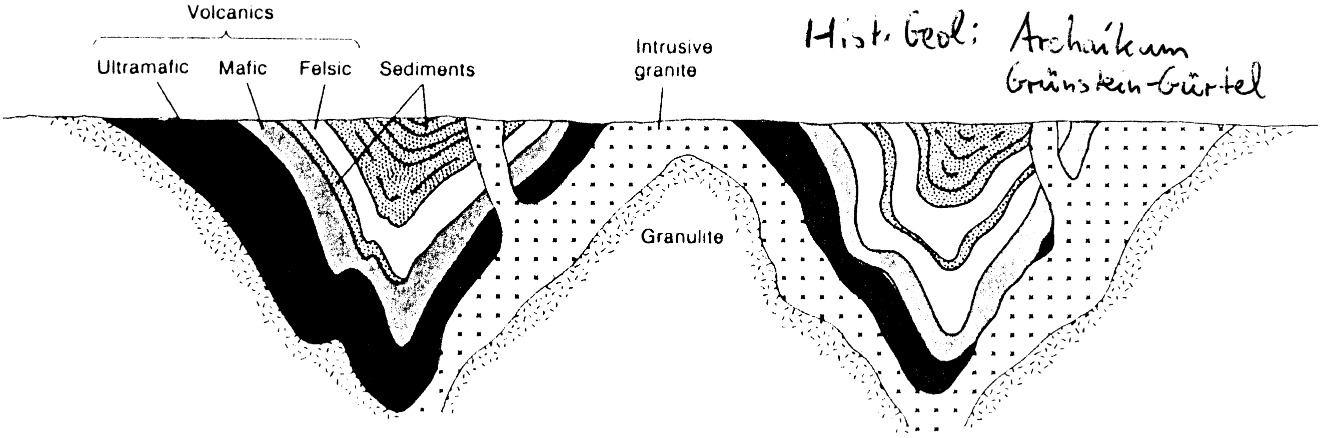


FIGURE 9-19 Diagrammatic cross section of two adjacent Archean greenstone "pods" within granulitic terrane. Each pod has a synclinal configuration. The oldest greenstone volcanics are ultramafic in composition, and these are overlain by mafic and the felsic volcanics; sediments are most abundant above the volcanics. Granites have invaded the volcanic rocks.

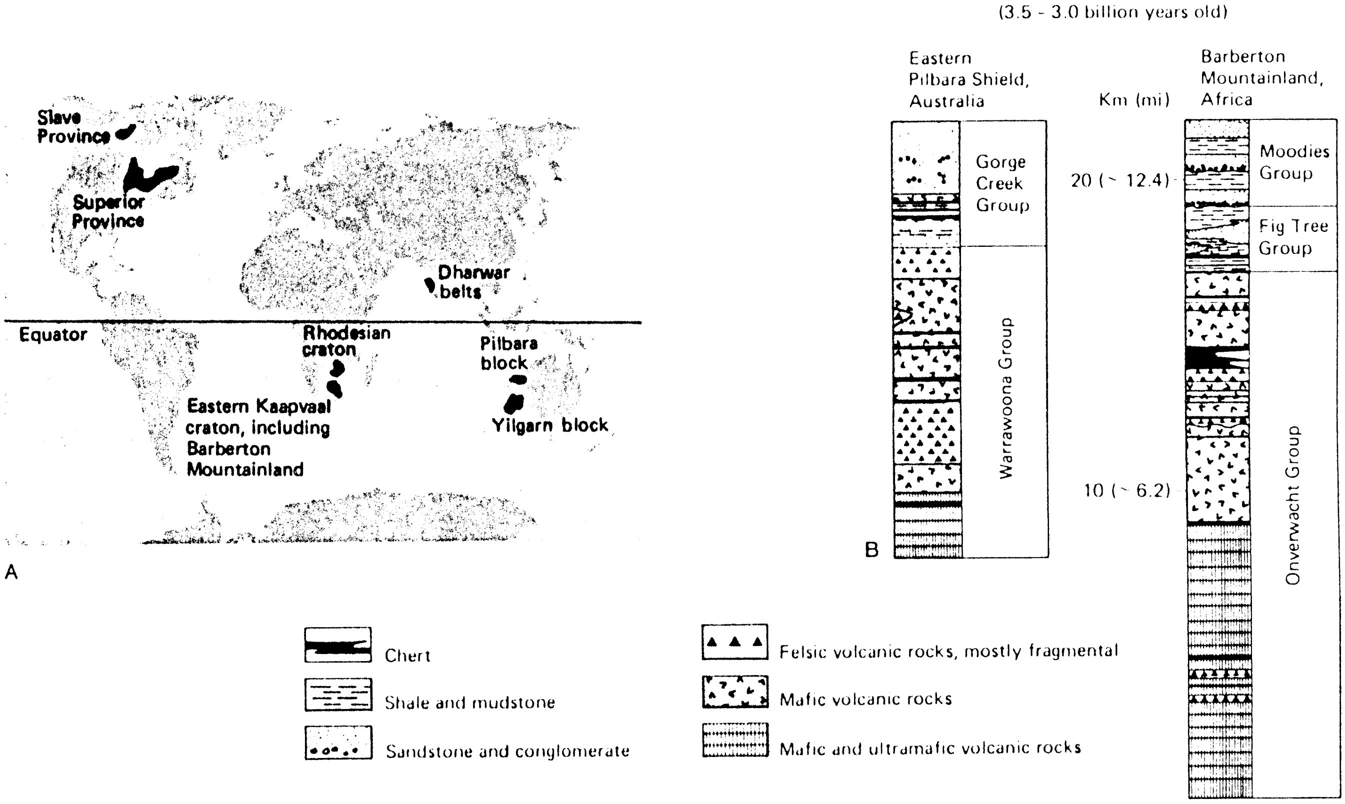
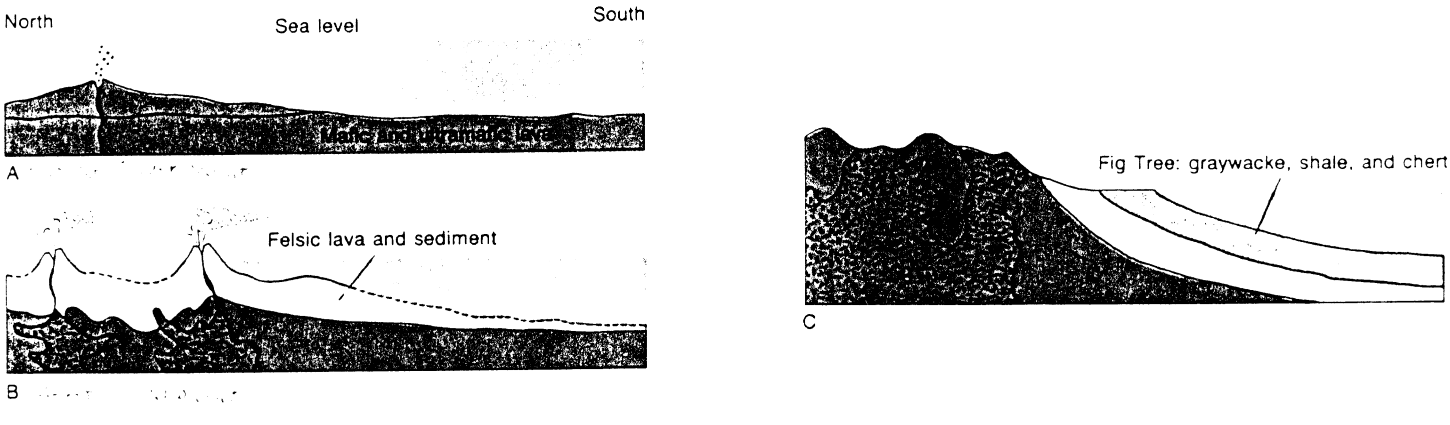
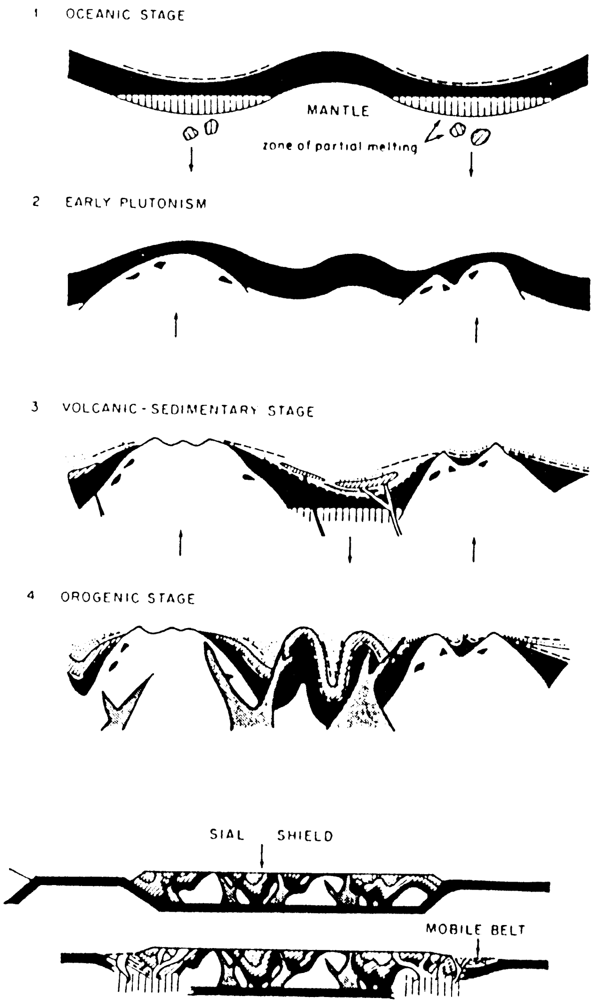


FIGURE 9-20 Shield areas containing well-preserved greenstone belts *(A)* and representative stratigraphic sections through two greenstone sequences *(B)*. In both of these sequences, there is a transition from ultramafic and mafic volcanics to felsic volcanics. *(After D. R. Lowe, Ann. Rev. Earth and Planet. Sci. 8:145–167, 1980.)*



Hist. Geol.: Archaikum
Krustenevolution



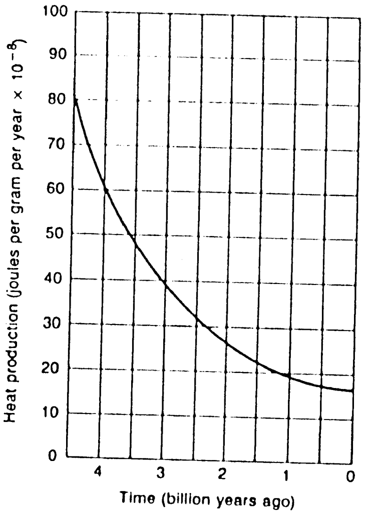


FIGURE 9-25 Decline in the earth's rate of heat production through time. *(After W. H. K. Lee, Ph.D. thesis, University of California at Los Angeles, 1967.)*

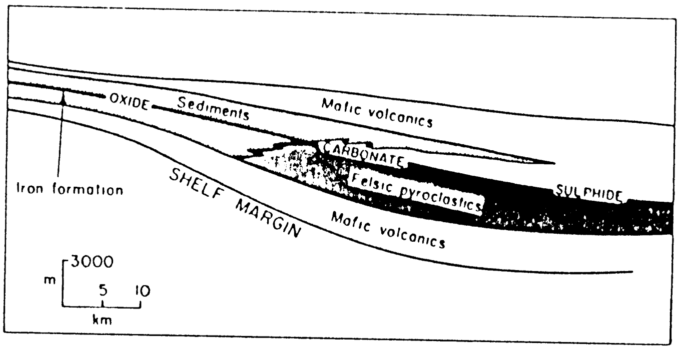


Fig. 3.11 Distribution of iron facies in the Abitibi belt, Canada. The oxide–carbonate–sulphide facies transitions delineate the original shelf-to-basin slope of the 'orogen' (redrawn after Goodwin, 1973b; reproduced by permission of *Economic Geology*)

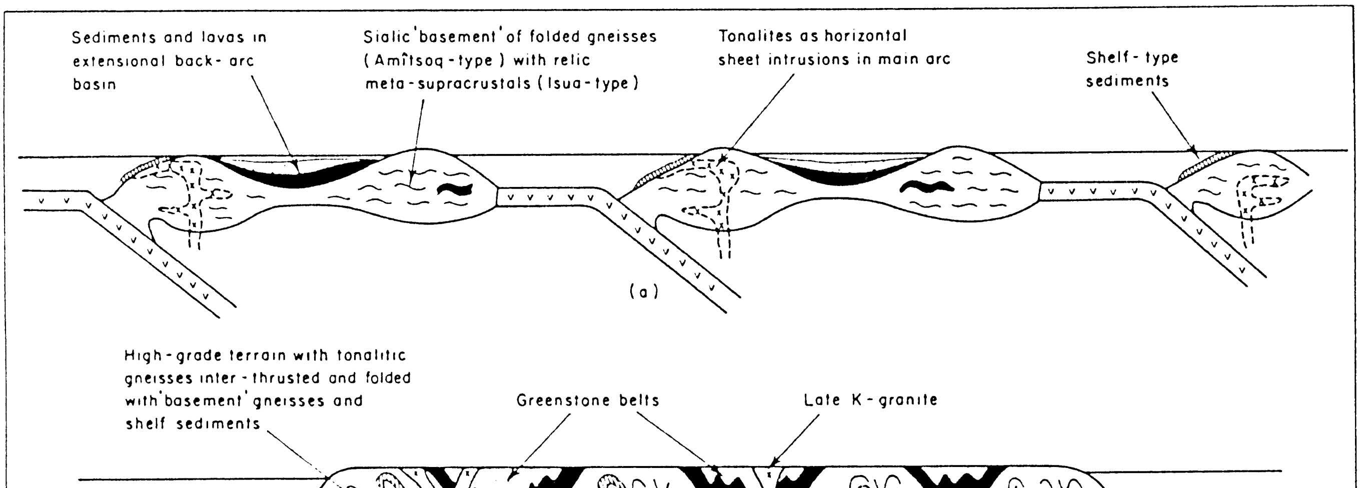


Fig. 4.9 A plate tectonic model to explain the growth of continents in the Archaean. (a) Widespread lateral movement of many early Archaean mini-continental plates with shelf-type quartzites, carbonates, and K-pelites and with mantle-derived tonalites in batholithic proportions in proto Andean-type arcs and of volcanics in back-arc environments. (b) Aggregation of mini-continents gives rise to extensive continental plate by the end of the Archaean consisting of greenstone belts, and granulite–gneiss belts with older and younger gneissic components. Amphibolite- to granulite-grade metamorphism (heat flow) and deformation of tonalites to give rise to tonalitic gneisses takes place in the roots of the main arc

Hist. Geol.: Archaikum, divers

(12)

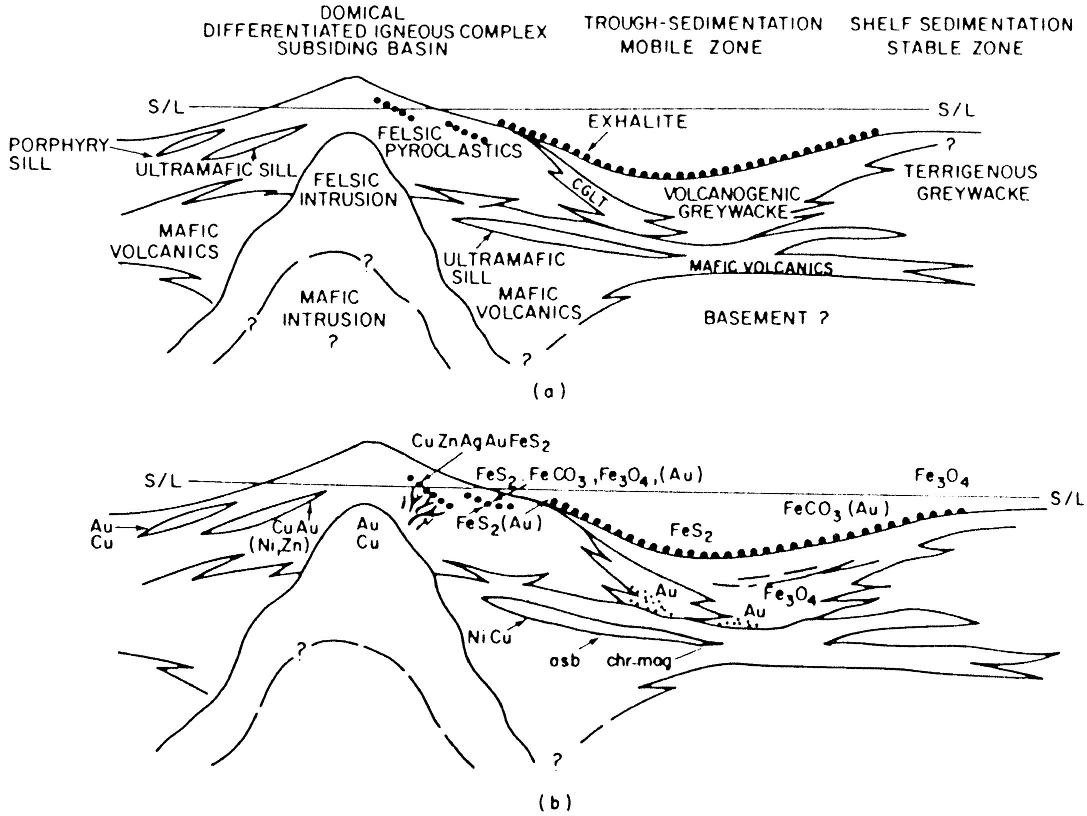


Fig. 3.8 A diagrammatic cross-section of the Abitibi belt. (a) Shows the tectonic–stratigraphic relations with the volcanic–sedimentary complex and (b) The main mineral deposits. Full width of section 50 miles, maximum vertical thickness 10 miles. (After Hutchinson *et al.*, 1971; reproduced by permission of *Trans. Can. Inst. Metall.*)

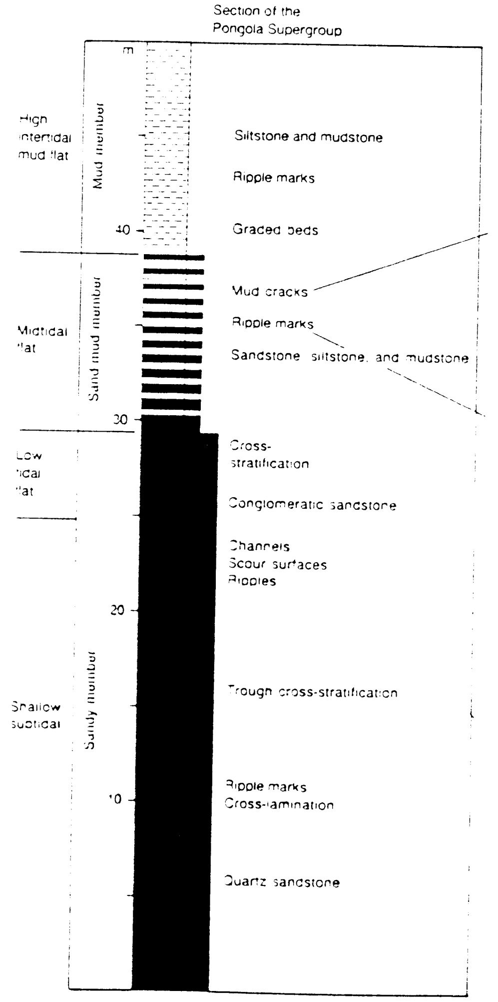


FIGURE 9-27 Depositional environments represented within a stratigraphic section of the Pongola Supergroup of southern Africa. The section represents a 3-billion-year-old regressive sequence in which a tidal flat prograded seaward over subtidal environments. In the lower, sandy member, cross-stratification and symmetrical ripples are common. Some of these ripples are double-crested, reflecting the ebb and flow of tides. Tidal channel deposits floored by pebbles are present, particularly in the upper part. Above them, the sand-mud member bears ripples and mud cracks that suggest a shallower, midtidal environment. The uppermost mud member bears smaller mud cracks as well as mud chips and appears to represent a high intertidal mud flat that lay landward of the zones where sand settled from tidal waters.

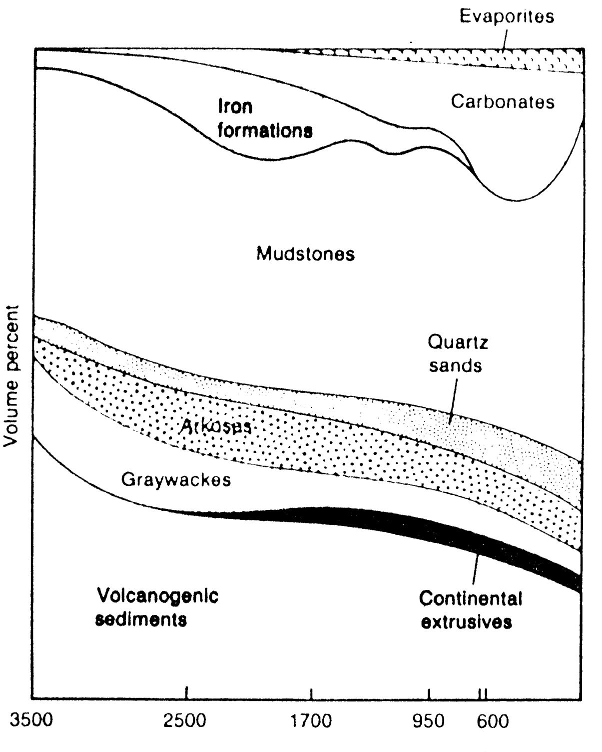
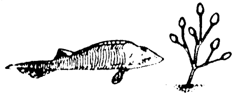
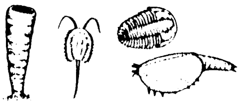
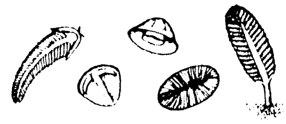
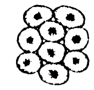
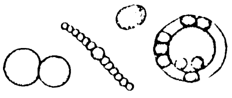


FIGURE 9-24 Changes in the relative proportions of rock laid down on cratonic surfaces in the course of geologic time. Notice the increase in evaporites, carbonates, and quartz sands after the Archean Eon. *(Modified from F.T. Mackenzie, in J. P. Riley and G. Skirrow [eds.], Chemical Oceanography, Academic Press, London, 1975. Based on data from A. B. Ronov.)*

Hüswücke Geol.: (13

Präkambrium
(Entwicklung des
Lebens)

Schlüsselereignis	Milliarden Jahre vor heute	überlieferte Lebensspuren	Sauerstoffanteil gegenüber heute	Begleitereignisse und Folgen
8. voller Sauerstoffgehalt	0,4	 große Fische, erste Landpflanzen	100	biosphärische Evolution bis heute
7. Vielzeller mit Außenskelett	0,55	 kambrische Fauna	~10	Grabspuren; Höherentwicklung
6. erste fossile Vielzeller	0,67	 Ediacara-Fauna	~7	fossile Vielzeller und „Fährten"
5. erste fossile eukaryontische Zellen	1,4	 Zellen mit größerem Durchmesser	>1	Rotsedimente nehmen zu, mehrzellige Organismen, Mitose, Meiose, genetische Rekombination
4. sauerstofftolerante Blaualgen	~2,0	 vergrößerte dickwandige Zellen, eingestreut in Zellketten von Blaualgen	~1	Atmungsstoffwechsel, Ozon-Schirm; älteste Rotsedimente überschneiden sich mit jüngsten gebänderten Eisensteinen
3. Photosynthese, wahrscheinlich sauerstofferzeugend	>2,8	 Stromatolithen	<1	Chlorophyll a und Cytochrom b; Formationen gebänderter Eisensteine und andere Sauerstoff-Senken; Treibhaus-Effekt nimmt ab
2. autotrophe Lebensweise Energiequelle: Methansynthese? Schwefeloxidation?	>3,5	 Stromatolithen, Sulfat, „leichter" Kohlenstoff	sauerstofflos	Strukturen, die heutigen ähneln
1. Entstehung des Lebens	(~3,8?)	 „leichter" Kohlenstoff	sauerstofflos	Beginn der biosphärischen Evolution

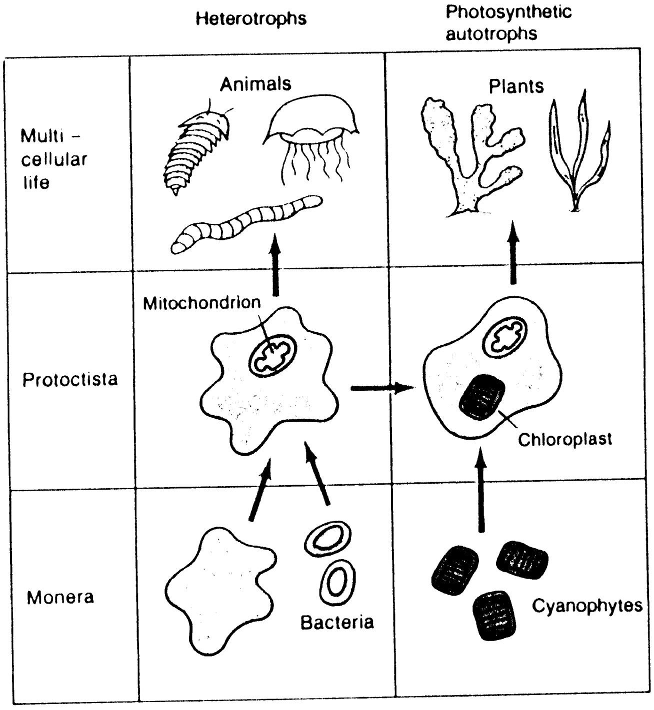


FIGURE 10-17 The probable sequence of major events leading from Monera to multicellular animals and plants. The first protoctist apparently evolved when one moneran engulfed but failed to digest another, which then became a mitochondrion. A plantlike protoctist evolved when an animal-like protoctist engulfed but failed to ingest a cyanobacteria cell, which then became a chloroplast.

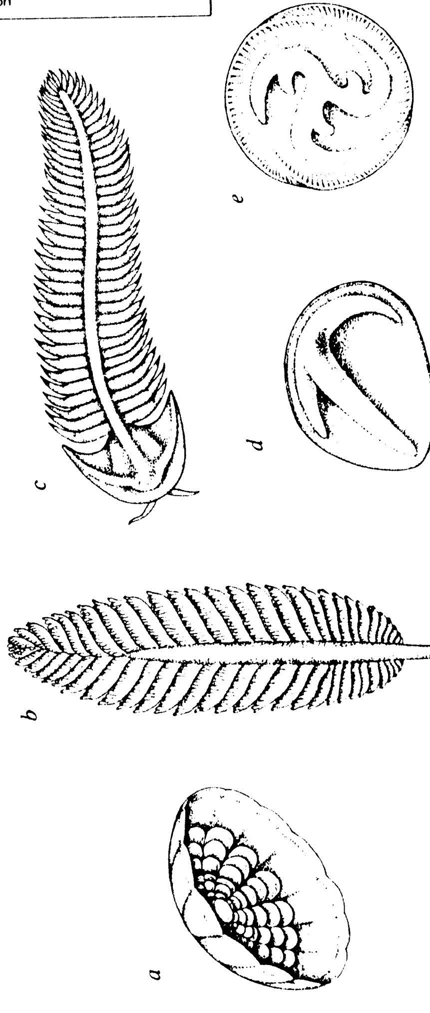


Bild 8: Tiere aus dem Präkambrium, wie sie erstmals in den Ediacara Hills im südlichen Australien entdeckt wurden, sind inzwischen von allen Kontinenten, außer dem antarktischen, bekannt. Am häufigsten kommen Tiere vor, die Quallen (a) oder anderen modernen Hohltieren wie den Seefedern (b) ähneln. Andere Tiere, *Spriggina* beispielsweise (c), ähneln weichhäutigen Gliederfüßern und Ringelwürmern. Wieder andere, *Parvancorina* (d) und *Tribrachidium* (e) etwa, sind mit keinem bekannten Tier vergleichbar. Alle diese Organismen nahmen den Sauerstoff aus dem umgebenden Wasser über ihre Körperoberfläche auf. So war natürlich eine dünne und große stoffwechselaktive Oberfläche von Vorteil.

Histor. Geol.: Lebensentwicklung im Proterozoikum - Alternative Interpretationen

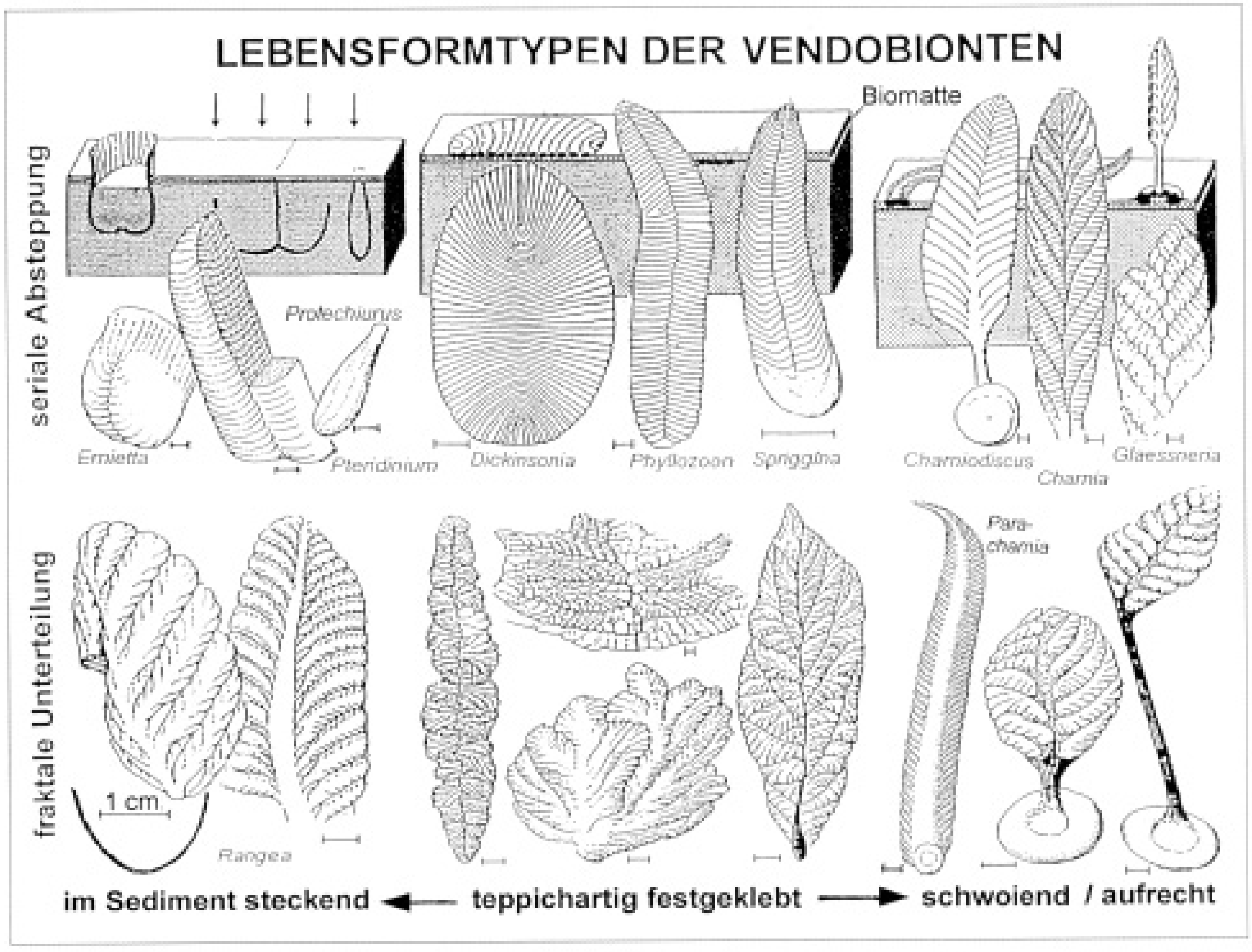


Abb. 4. Wertet man nicht die Gestalt, sondern die Steppdecken-Konstruktion als verbindendes Merkmal, hat die hypothetische Gruppe der Vendobionten eine erstaunliche Vielfalt entwickelt. Das gilt sowohl für Formen, welche durch seriale Angliederung neuer Kammern konstanten Durchmessers gewachsen sind, als auch für solche, deren Kammern sich beim Wachstum ausdehnten und durch sekundäre Absteppungen fraktal unterteilt wurden. Eine solche morphogenetische Plastizität wäre bei Metazoen kaum zu erwarten.

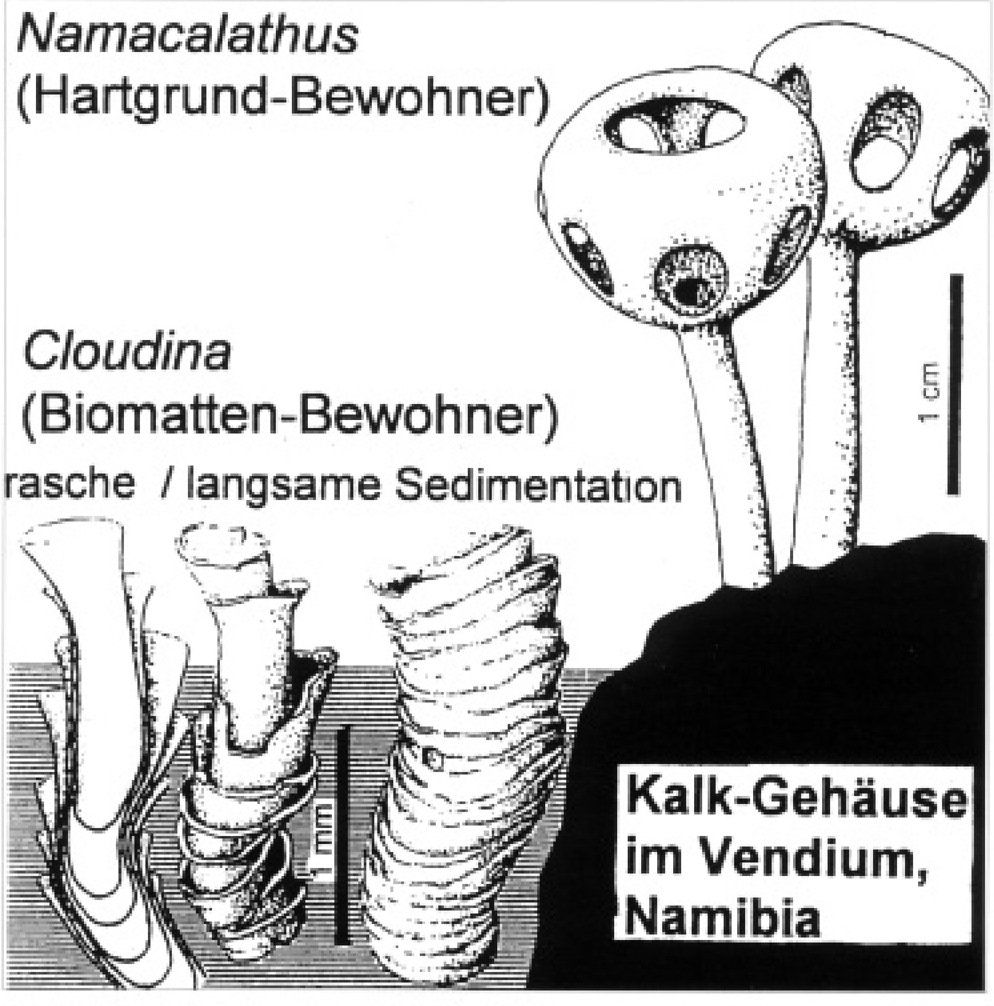


Abb. 13. Diese Fossilien aus Seilacher[19] und Grotzinger et al.[9] zeigen, dass Kalkskelette nicht erst in der kambrischen Explosion erfunden wurden. Im Präkambrium beschränkte sich die Biomineralisation jedoch auf festsitzende Organismen ungewisser Zugehörigkeit.

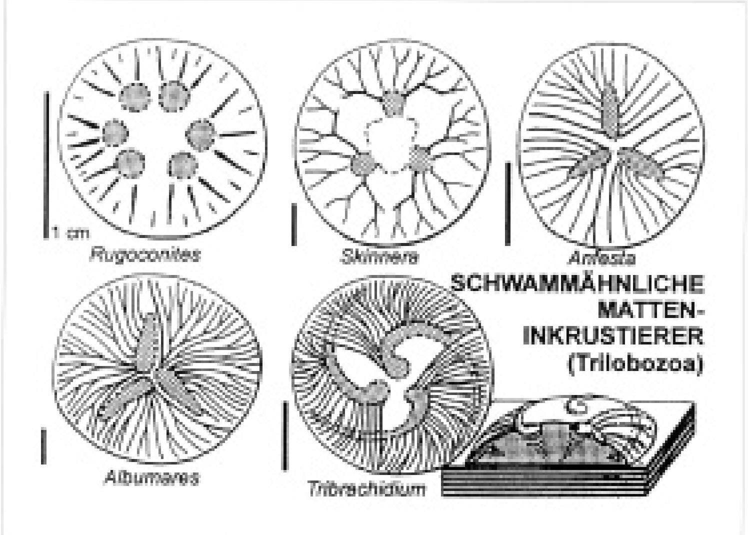


Abb. 12 . Die problematischen Trilobozoa sind zwar wie Vendobionten als "Totenmasken" der Oberseite erhalten, waren aber anders konstruiert. Aufgrund des zu- und abführenden Kanalsystems werden sie hier als Schwämme gedeutet, welche die präkambrischen Biomatten inkrustierten.

Aus Seilacher, A. (2003): Der Garten von Ediacara und die Kambrische Explosion.- Museo, 19, 70-81, Heilbronn.

Historische Geologie: Proterozoikum; BIF's; Tillite

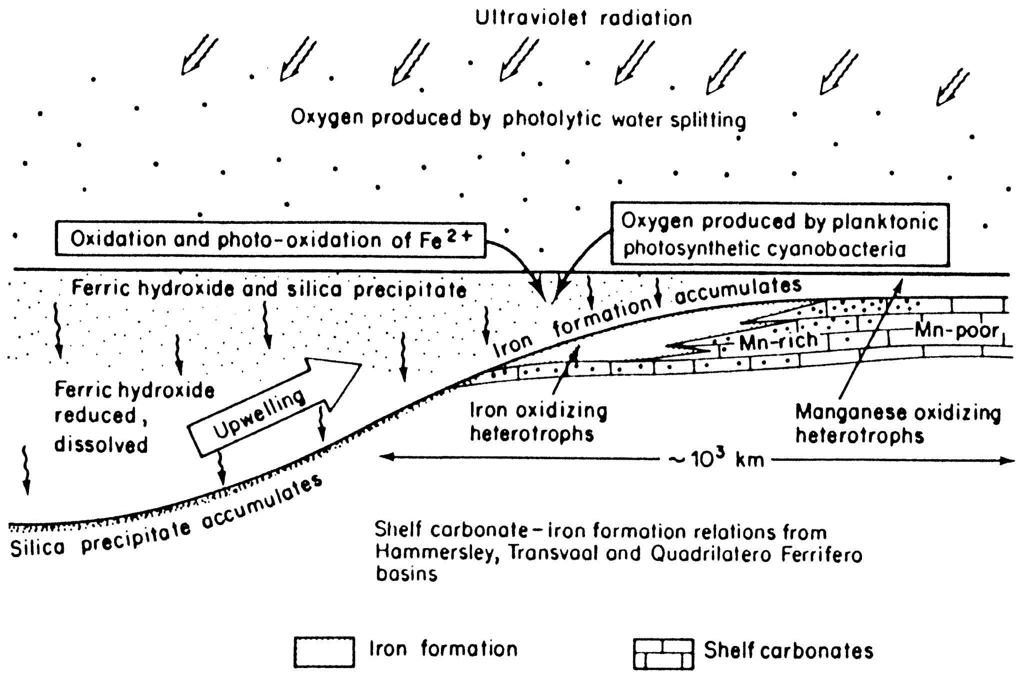


Fig. 6.12 Model for the deposition of Superior-type banded iron formations on a continental shelf in association with carbonates (from Goodwin, 1982b, *Rev. Bras. Geoc.*)

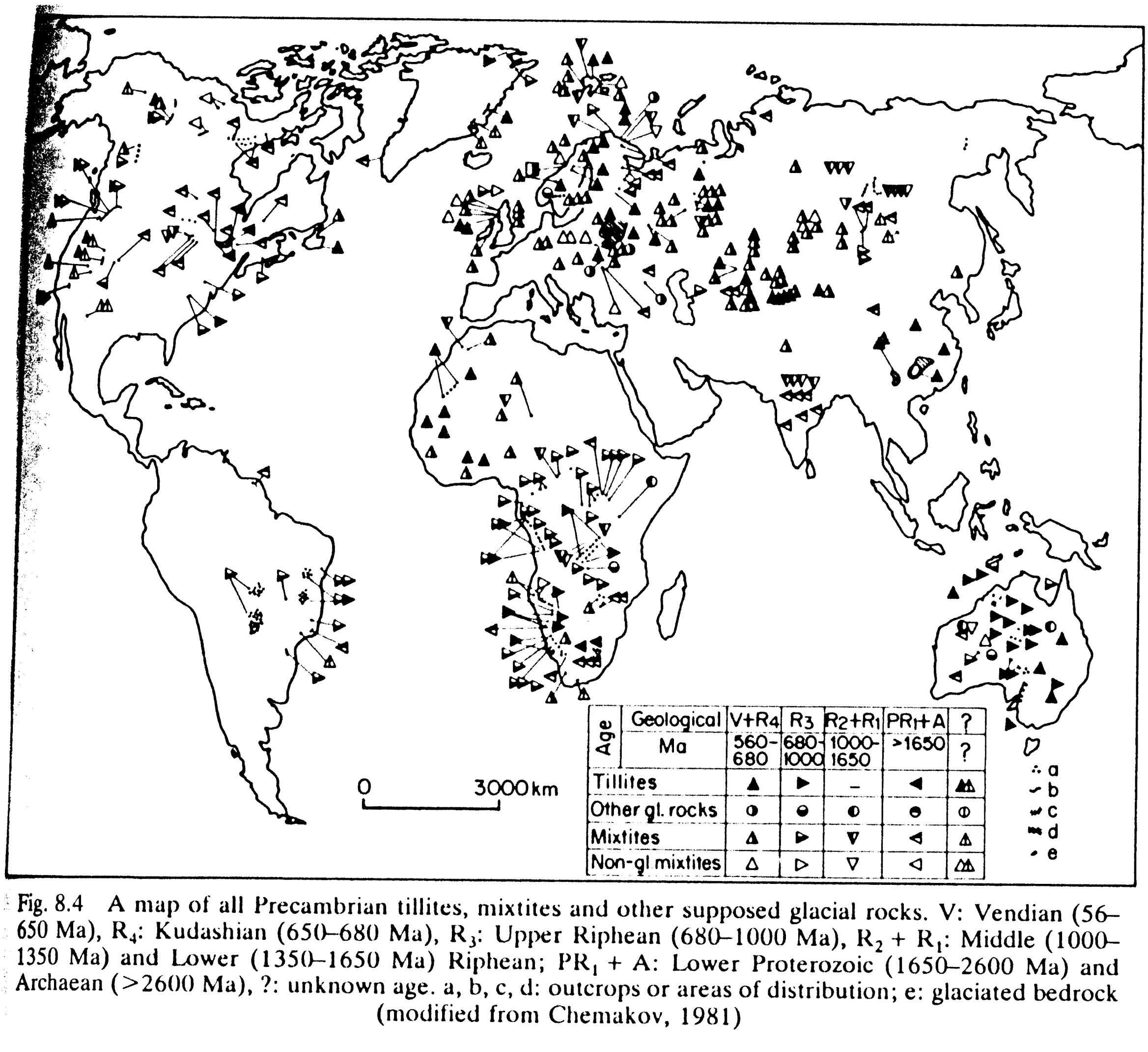


Fig. 8.4 A map of all Precambrian tillites, mixtites and other supposed glacial rocks. V: Vendian (56–650 Ma), R_4: Kudashian (650–680 Ma), R_3: Upper Riphean (680–1000 Ma), $R_2 + R_1$: Middle (1000–1350 Ma) and Lower (1350–1650 Ma) Riphean; PR_1 + A: Lower Proterozoic (1650–2600 Ma) and Archaean (>2600 Ma), ?: unknown age. a, b, c, d: outcrops or areas of distribution; e: glaciated bedrock (modified from Chemakov, 1981)

Hist.Geol. (16): Proterozoikum Übersicht

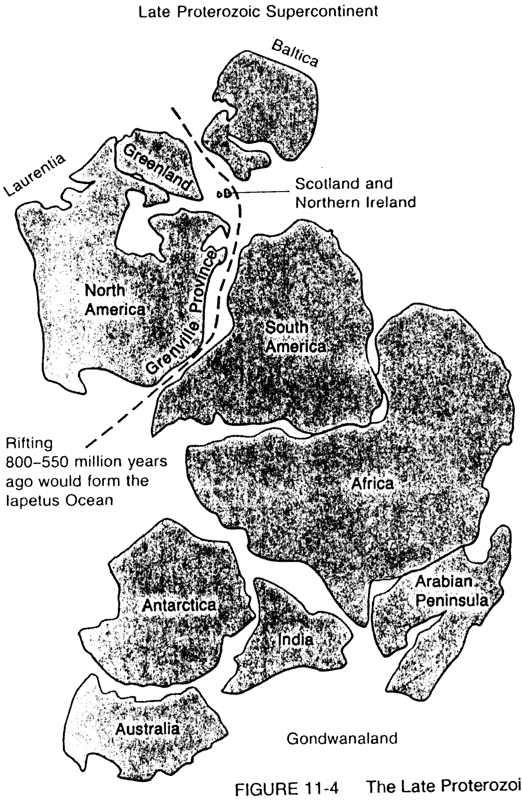


FIGURE 11-4 The Late Proterozoic supercontinent before it rifted apart to form the Iapetus Ocean and the continents Laurentia, Baltica, and Gondwanaland. Possibly northern Africa, rather than South America, was attached to eastern North America; the geologic evidence is unclear.

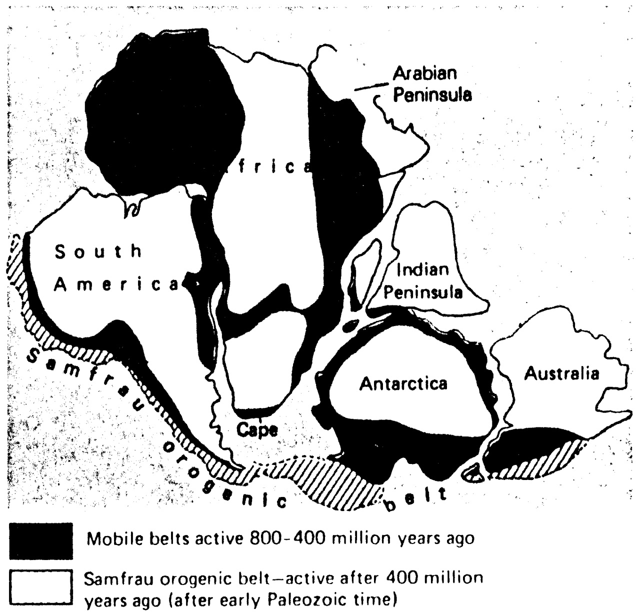


FIGURE 11-18 Modern continents reassembled into their relative positions within Gondwanaland. Note that many of the mobile belts that were active in Late Proterozoic and early Paleozoic time correspond to the lines along which Gondwanaland later broke apart.

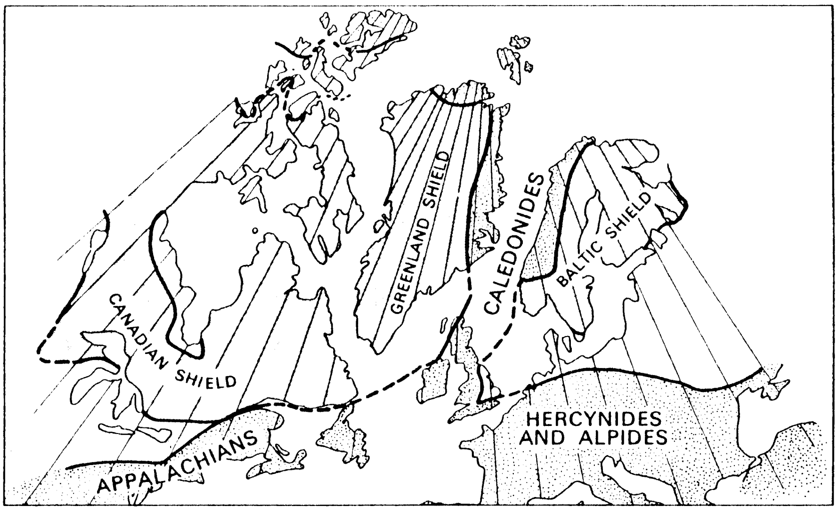


Fig. 3.1. Continental restoration of Greenland, Europe and North America in early Phanerozoic times, showing Precambrian shields, platforms and mobile belts

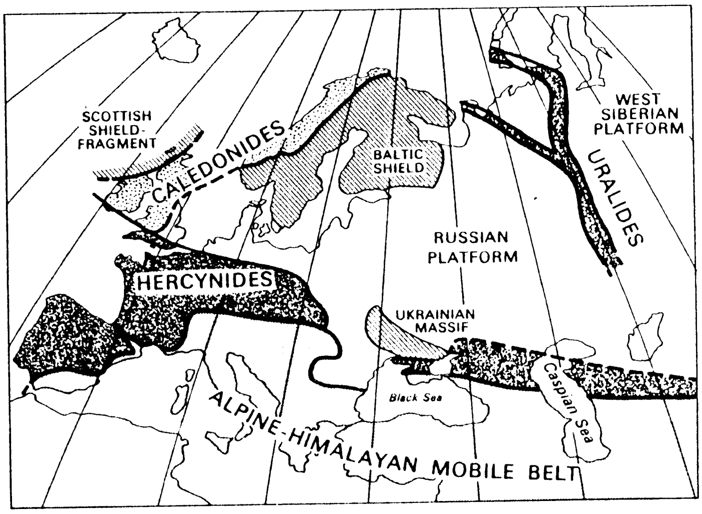


Fig. 2.1. The main tectonic units of Europe and western Asia

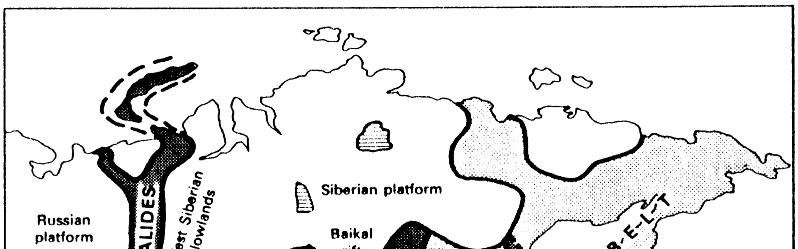


Fig. 5.1. The main tectonic units of Asia

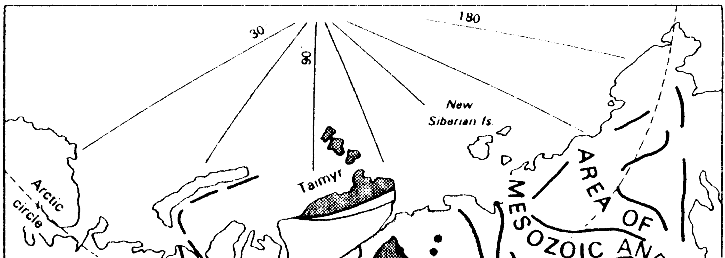
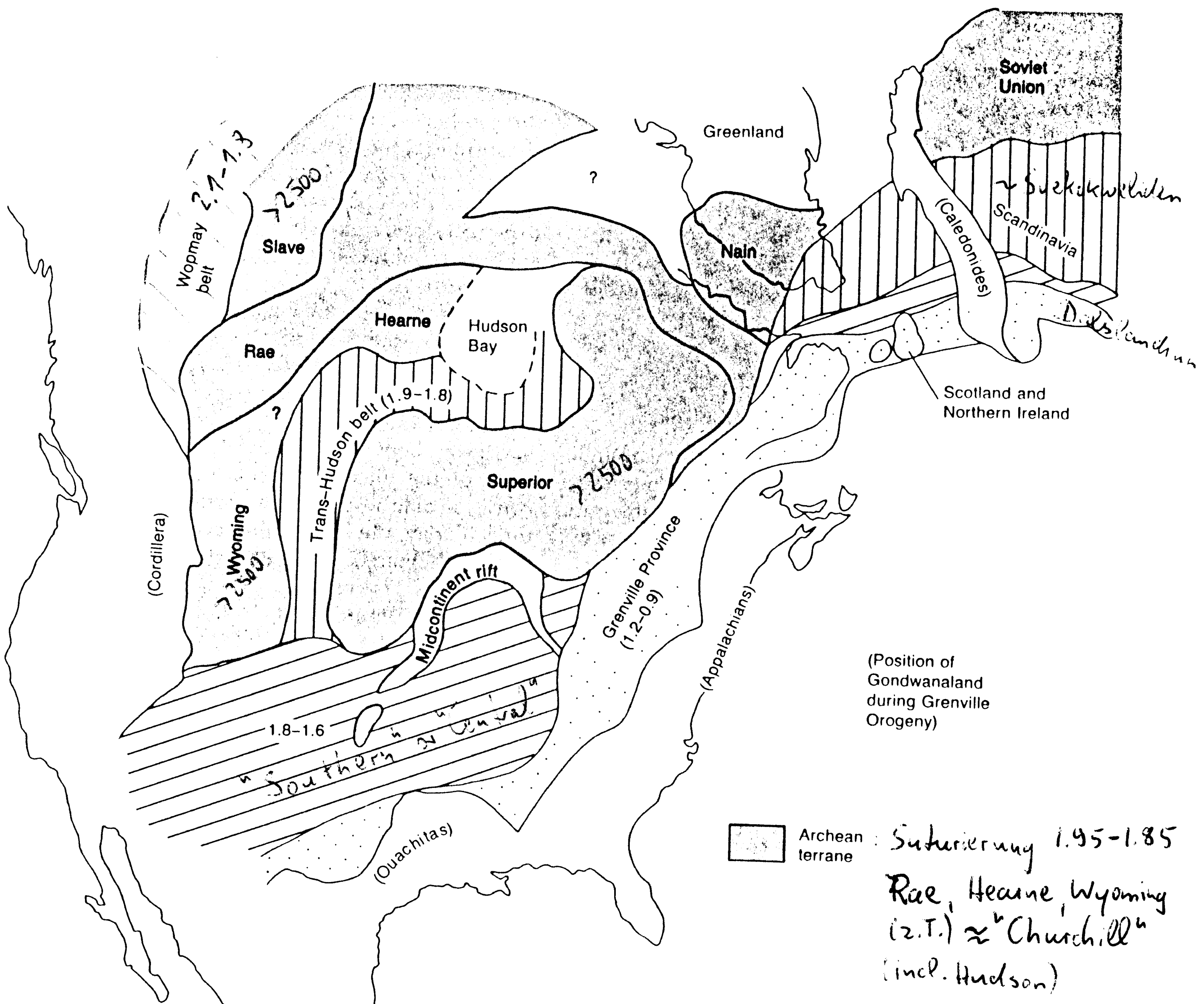


Fig. 5.2. The Siberian craton with the Phanerozoic mobile belts at its margin

Histor. Geologie ⑰: Proterozoikum, N-Amerika



Suturierung 1.95-1.85
Rae, Hearne, Wyoming (z.T.) ≈ "Churchill" (incl. Hudson)

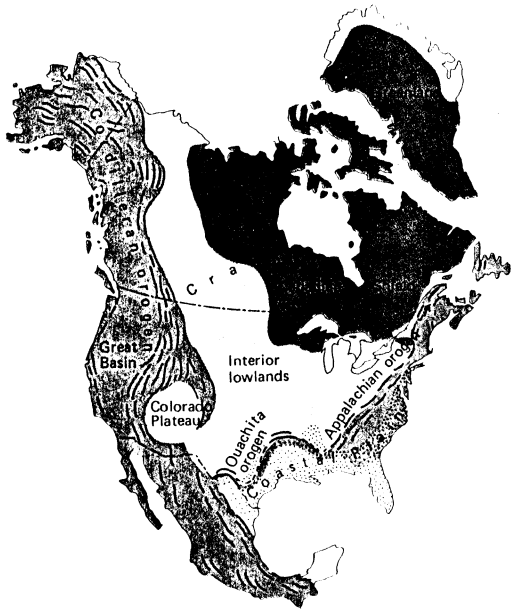
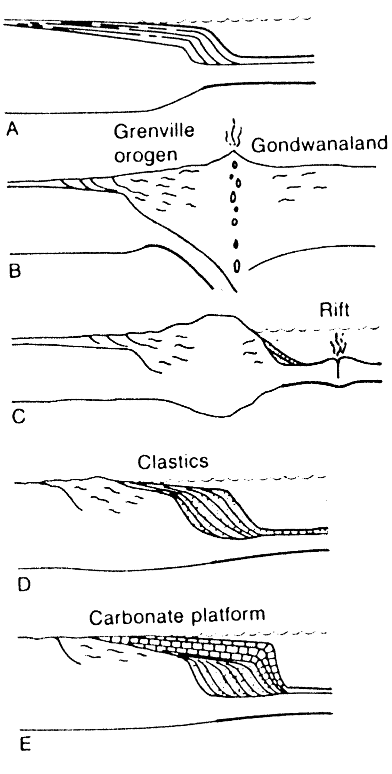


FIGURE 11-2 Major geologic features of North America. The Canadian Shield ends where sediments of the interior lowlands lap over it on the south and west. The Cordilleran, Ouachitas, and Appalachian orogens flank the North American craton on the west, south, and east.



A: 1.4-1.0 billion years ago
Shelf deposition of Grenville Province sediments

B: 1.2-1.0 billion years ago
Grenville orogeny related to collision with Gondwanaland

C: 800-550 million years ago
Rifting separates North America from Gondwanaland

D: Early Cambrian
Siliciclastic
Siliciclastic deposition along a new shelf

E: Cambro-Ordovician (above basal Cambrian)
Enormous carbonate platform

istor. Geologie (18): N-Amerika
roterozoikum NW-Europa

N. Amerika

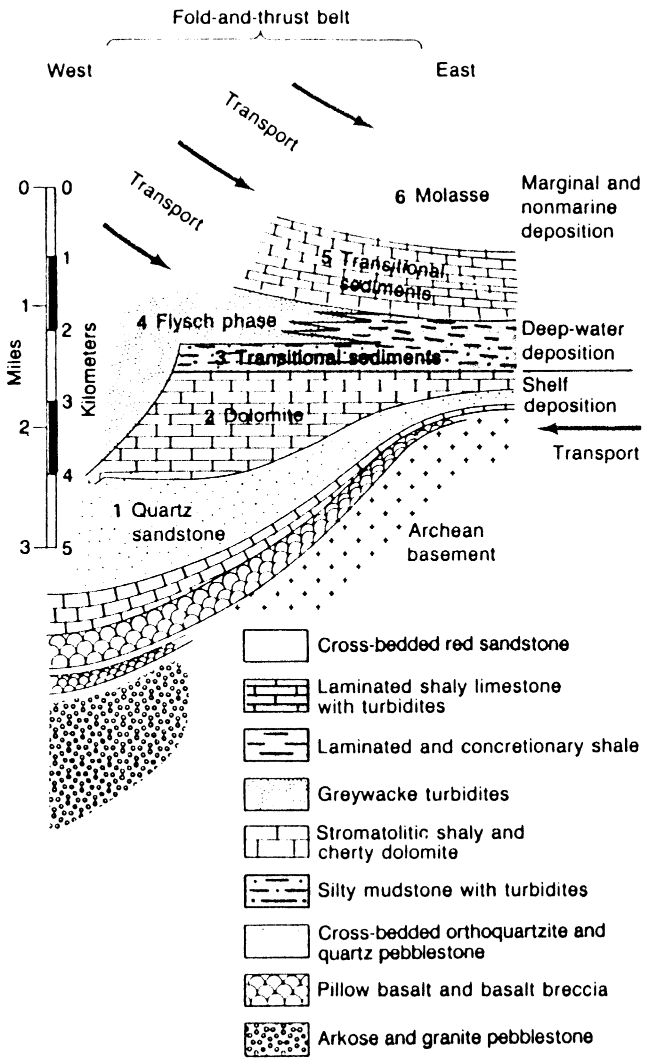
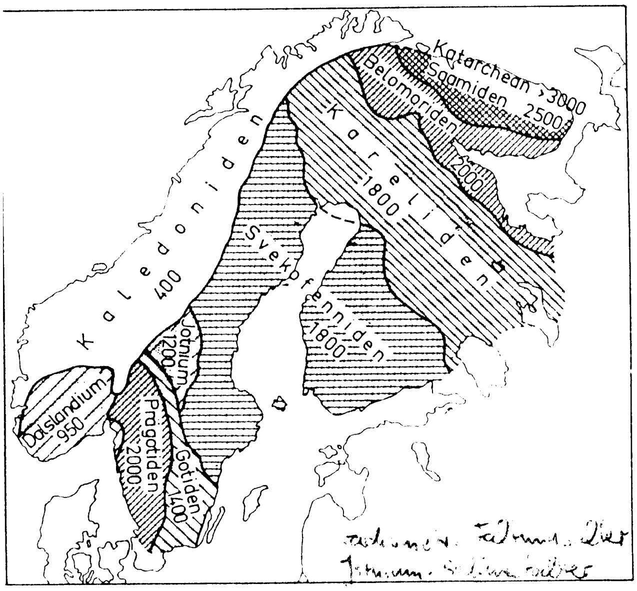


FIGURE 10-4 Diagram showing the sequence of development of sediments in the fold-and-thrust belt of the Wopmay orogen; numbers refer to depositional units described in the text. Units 1 and 2 represent marine deposition along a shallow continental shelf. Units 3 and 4 are deep-water deposits, including flysch, that accumulated when the shelf foundered as mountain building began to the west. Unit 5 consists of shallow-water deposits transitional between flysch below and molasse above. Unit 6, the molasse phase of deposition, followed the exclusion of marine waters by a heavy influx of sediment from the west. *(After P. H. Hoffman, in M. R. Walter [ed.], Stromatolites, Elsevier Publishing Company, Amsterdam, 1976.)*



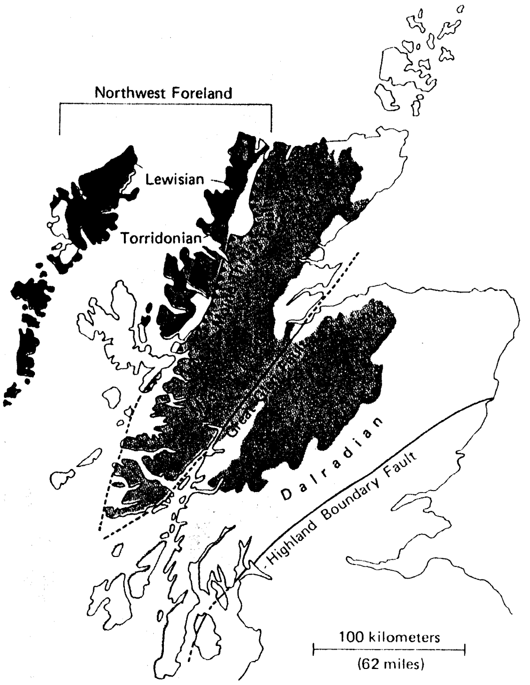


FIGURE 11-9 Precambrian rocks of Scotland. The oldest ones are the crystalline rocks of the Lewisian sequence. The younger rocks are sedimentary. The stratigraphic sequence of these rocks is shown in Figure 11-10.

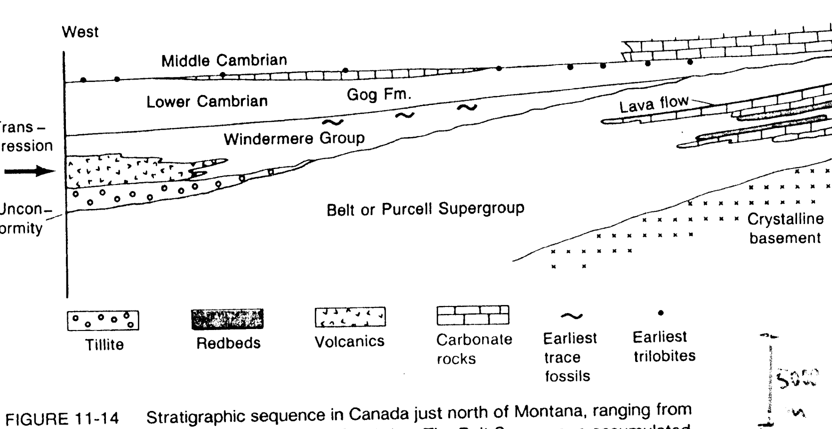


FIGURE 11-14 Stratigraphic sequence in Canada just north of Montana, ranging from the Middle Proterozoic through the Middle Cambrian. The Belt Supergroup accumulated in a large basin (Figure 11-6). *(Modified from P. B. King, The Evolution of North America, Princeton University Press, Princeton, New Jersey, 1977.)*

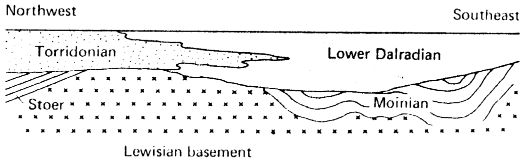


FIGURE 11-10 Stratigraphic cross section of Precambrian rocks in northern Scotland and Ireland *(above)* and the generalized geography of northern Scotland and Ireland when Torridonian and Dalradian sediments were deposited near the end of the Precambrian *(below)*; these regions were attached to Greenland along the margin of the Iapetus Ocean.

Histor. Geologie ⑲ : Proterozoikum

Abfolgen und Strukturen (Beispiele)

Table 2.2. THE SVECOFENNIAN SUCCESION OF TAMPERE
(based on Simonen, 1960) Skandinavien

		Thickness (metres)
Upper Svecofennian	dominantly pelitic (not represented in the Tampere district itself)	
Middle Svecofennian	basic volcanics	1000
	conglomerates, greywacke-slates and arkoses	7800
	basic and intermediate volcanics	800–1500
Lower Svecofennian	Quartzofeldspathic rocks (arkoses, greywackes, pyroclastics)	1500–2200
(no base known)	greywacke-slates	3000

Table 4.2. THE HURONIAN SUPERGROUP (N-Amerika)
(The succession of the type region, based on Roscoe, 1968)

	Group		Formation	Lithological types
	COBALT		Bar River	quartzite (siltstone)
			Gordon Lake	siltstone
			Lorrain	quartzite, arkose argillite
			Gowganda	conglomeratic greywacke (tillite?) arkose
BRUCE DIVISION	QUIRKE LAKE		Serpent	arkose, sub-greywacke
			Espanola	dolomite, limestone, siltstone, greywacke
			Bruce	conglomeratic greywacke
	HOUGH LAKE	Mississagi Quartzite	Mississagi	coarse sub-greywacke
			Pecors	argillite, siltstone
			Ramsay Lake	conglomeratic greywacke
	ELLIOT LAKE		McKim	sub-greywacke,
			Matinenda	argillite, arkose, uraniferous conglomerate
			Copper Cliff	acid volcanics
			Thessalon, Pater, Stobie	basic volcanics
			Livingston Creek	arkose

Table 8.2. THE PROTEROZOIC SUCCESSION OF THE HAMERSLEY RANGES
(based on McLeod, 1966) Australien

			GRANITE INTRUSIONS, FOLDING	THOLEIITE DYKES AND SILLS
BANGEMALL GROUP		thickness variable but locally over 6000 m: mainly stromatolitic dolomites and sandstones, locally conglomerates, acid lavas: apparent ages of about 1100 m.y. from black shales and lavas		↑
unconformity				
BRESNAHAN GROUP		thickness put at 13 000 m conglomerates followed by current-bedded sandstones.		
unconformity				
MOUNT BRUCE SUPER-GROUP	WYLOO GROUP	3000 m: unstable shelf-deposits, conglomerates, sandstones, siltstones, dolomites and basalts: contemporaneous acid intrusions dated at 2020 m.y.	↑	
	HAMERSLEY GROUP	2600 m: mainly chemical deposits, jaspilites, cherts, dolomites and banded iron formations: a rhyolite group near top dated at 2000 m.y.		
	FORTESCUE GROUP	2000–5000 m: mainly basalts and pyroclastics, with sandstones, cherts, dolomites: contemporaneous intrusions dated at c. 2200 m.y.		
major unconformity				
ARCHAEAN BASEMENT OF PILBARA BLOCK			↓	↓

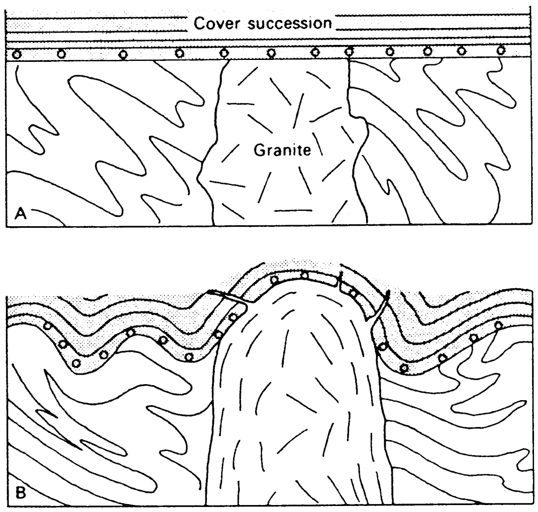


Fig. 2.6. Mantled gneiss domes: diagrammatic sections, based on Eskola, illustrating the structure before (A) and after (B) regeneration of the basement

Karelids

↑

Skandinavien

↓

Fig. 2.5. Dykes as time-markers: a metabasaltic dyke (tinted) cuts migmatised conglomeratic schist of the Svecofennian succession and is itself veined by the Rysskär granite (from a photograph illustrating Sederholm's study of migmatisation)

Histor. Geologie ⑳: Präkambrium, Gondwana-Kontinente

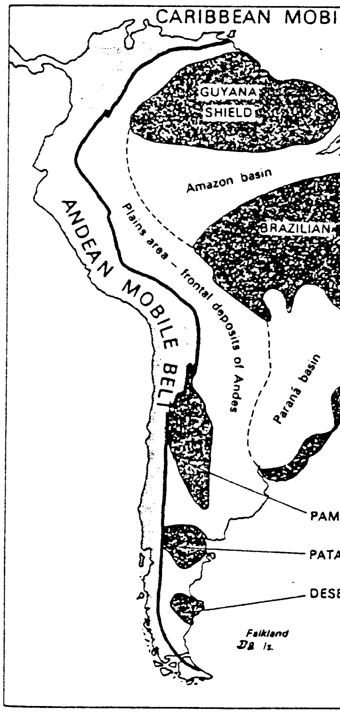


Fig. 9.1. The main geological units of South America

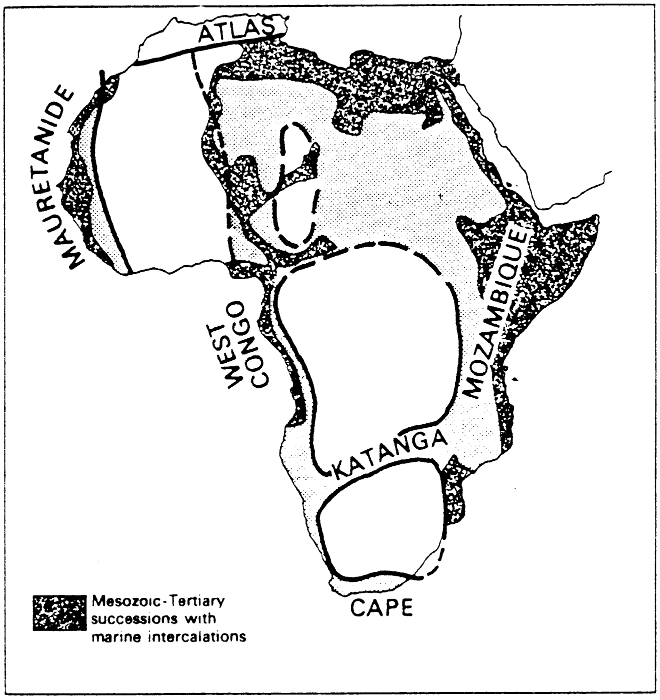


Fig. 6.2. The network of late Precambrian–early Palaeozoic mobile belts in Africa with the principal outcrops of marine Mesozoic and Tertiary sediments superimposed (based on Kennedy, 1965)

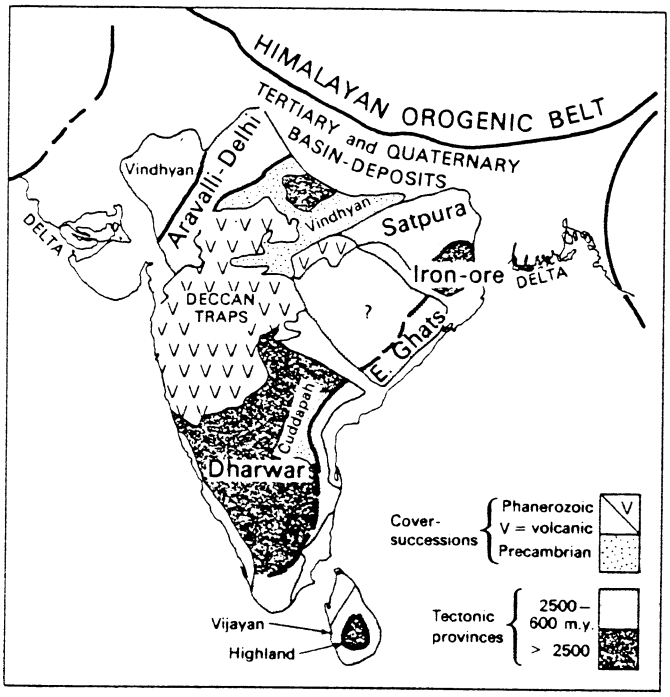


Fig. 7.1. The main geological units of peninsular India

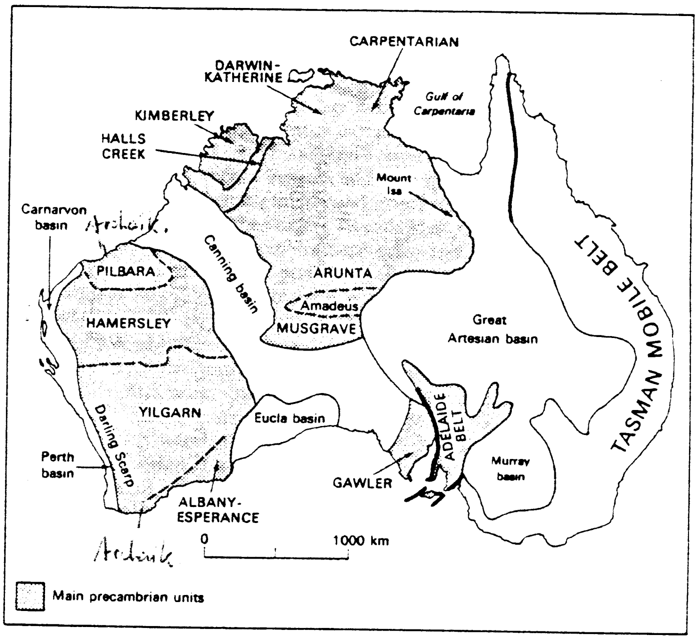


Fig. 8.2. Simplified map of Australia showing the main Precambrian units mentioned in Chapter 8 (indicated by capital lettering) and the main Phanerozoic basins of deposition

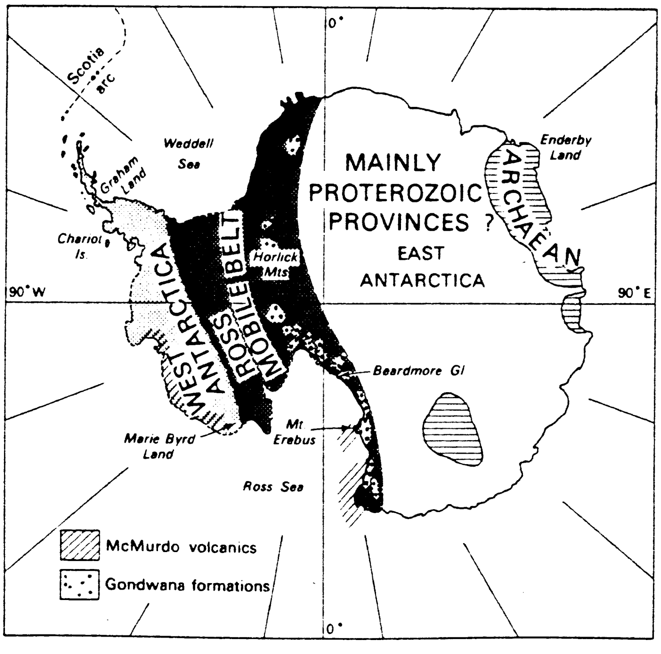


Fig. 9.4. The main geological units of Antarctica

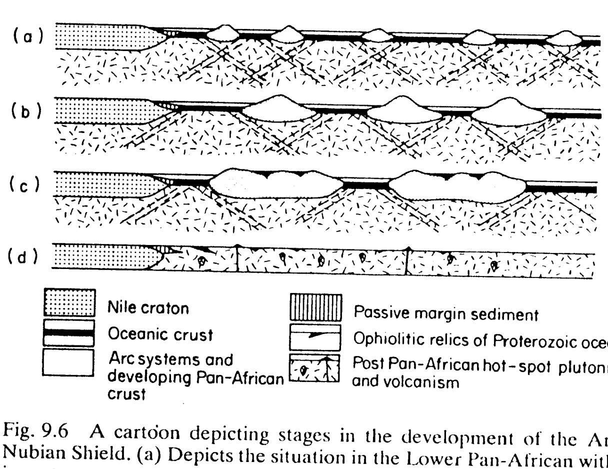


Fig. 9.6 A cartoon depicting stages in the development of the Arabian–Nubian Shield. (a) Depicts the situation in the Lower Pan-African with many immature arc systems. By Middle Pan-African times (b) the arcs have matured and coalesced but have not attained continental dimensions. By Upper Pan-African times (c) the arcs have coalesced into continents but these still overlay subduction zones and magmatic activity had calc-alkaline affinity. (d) Depicts the post Pan-African (500–600 Ma) situation. When the continent was fully developed, subduction had ceased and magmatism was per alkaline and of within-plate affinity (from Gass, 1981, reproduced by permission of Elsevier, Amsterdam)