SVERIGES GEOLOGISKA UNDERSÖKNING

SER. Ca AVHANDLINGAR OCH UPPSATSER I A 4 NR 54

JAN BERGSTRÖM, BRIAN HOLLAND, KENT LARSSON,
ERIK NORLING AND ULF SIVHED

GUIDE TO EXCURSIONS IN SCANIA

UPPSALA 1982

CA 54 - ERRATA & ADDENDA

p. 9, lines 14-15, omit "and Tertiary".
p.24, line 7 from bottom, should read "As seen in Figs 11 and 12..."
p.46, Fig 26 is redrawn from Kumpas 1980, Fig 64. The section is roughly 1000 m deep and 30 km long.

Kumpas, M.G., 1980: Seismic stratigraphy and tectonics in Hanö Bay, southern Baltic. Stockholm Contributions in Geology, 34:4, pp.35-168.

Moberg, J.C,. 1988: Om lias i sydöstra Skåne. Sver. geol. Unders., Ser.C 99, 88 pp.

Norling, E., 1976: In B. Ringberg: Beskrivning till jordartskartan Malmö NV, pp.20-28. Sver. geol. Unders., Ser. C 579, 100 pp.

Ortli, H.J., Brotzen, F. & Bartenstein, H., 1961: Mikropaläontologisch-feinstratigraphische Untersuchung der Jura-Kreide Grenzschichten in Südschweden. Sver. geol. Under., Ser. C 579, 24 pp.

Rolle, F., Koch, J., Frandsen, N. & Surlyk, F., 1979: Jurassic environments in the Fenno-scandian borderzone. Symposium "Sédimentation jurassique W européen". A.S.F. Publication spéciale no I, pp. 15-31.

Tralau, H., 1966: Botanical investigations in the fossil flora of Eriksdal in Fyledalen, Scania. Sver. geol. Unders., Ser. C 611, 36 pp.

Tralau, H., 1968 Botanical investigations into the fossil flora of Eriksdal in Fyledalen, Scania. II. The Middle Jurassic Microflora. Sver. geol. Unders., Ser. C 633, 185 pp.

Wikman, H., Norling, E., Sivhed, U. & Karis, L., 1981: Berggrundskartan 3B Höganäs NO/3C Helsingborg NV. Sver. geol. Unders., Ser. Af 129.

SVERIGES GEOLOGISKA UNDERSÖKNING

SER. Ca AVHANDLINGAR OCH UPPSATSER I A 4 NR 54

JAN BERGSTRÖM, BRIAN HOLLAND, KENT LARSSON,
ERIK NORLING AND ULF SIVHED

GUIDE TO EXCURSIONS IN SCANIA

UPPSALA 1982

ISBN 91-7158-274-6
ISSN 0348-1352

8th International Working Meeting of the Project East European
Platform, SW Border (Key title: Project Tornquist) to be held
in Scania, Sweden and Bornholm, Denmark,
from 26 September to 2nd October 1982

GUIDE TO EXCURSIONS IN SCANIA

with contributions from

Jan Bergström (editor)
Brian Holland
Kent Larsson
Erik Norling
Ulf Sivhed

INTERNATIONAL GEOLOGICAL CORRELATION PROGRAMME

PROJECT TORNQUIST (IGCP Accession No. 86)

IUGS
UNESCO
IGCP

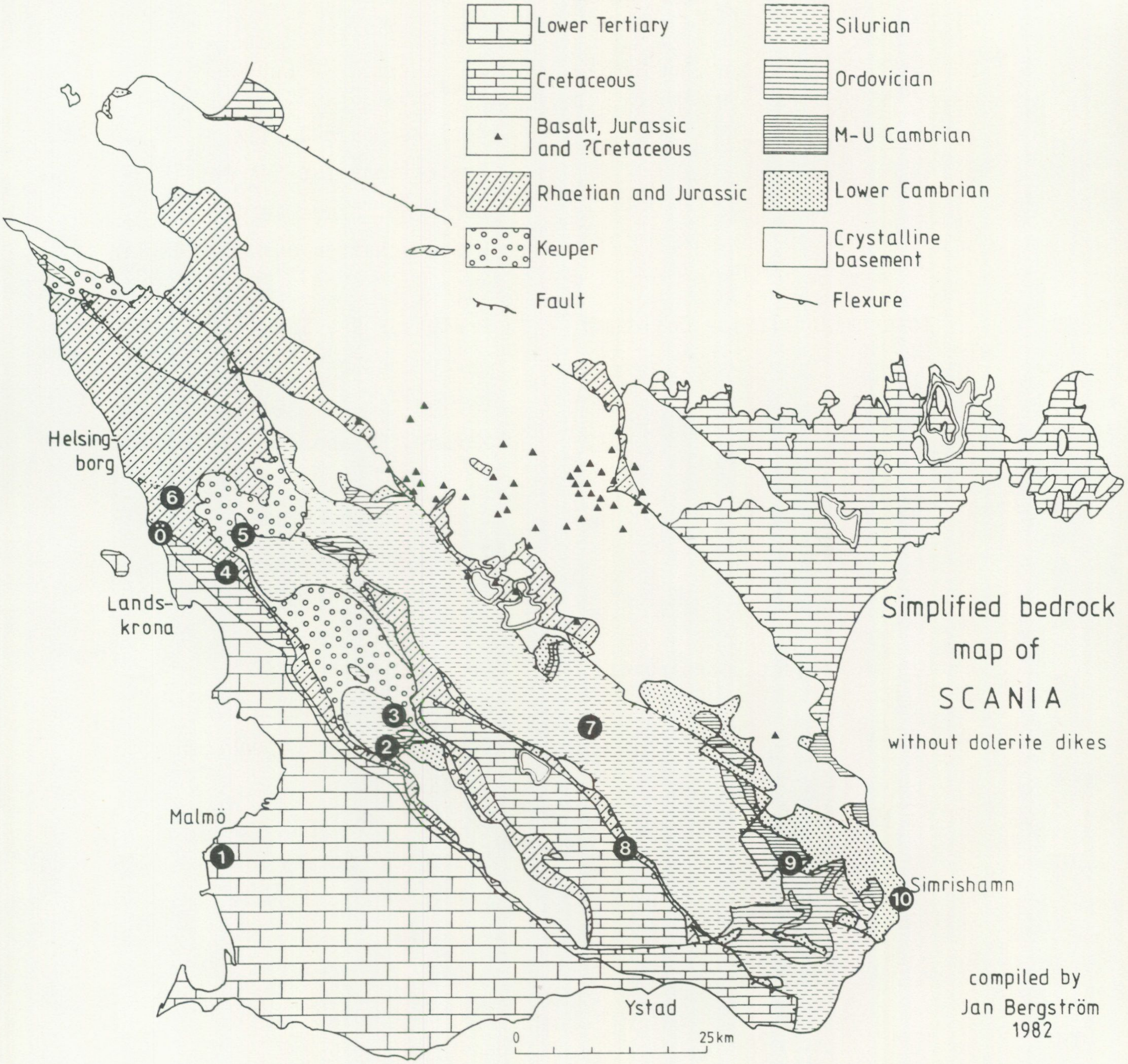


Fig. 1. Simplified bedrock map of Scania with excursion stops. Ö, Örenäs slott; 1, Limhamn Quarry; 2, Hardeberga: 3, Ö. Odarslöv; 4, Rönneberga backar; 5, Rönnarp; 6, Gantofta; 7, Bjärsjölagård; 8, Eriksdal; 9, Komstad area; 10, Simrislund.

PROJECT TORNQUIST (IGCP Accession No. 86)

International Chairman:	Professor Dr. Sc. Karl-Bernhard Jubitz Zentralinstitut für Physik der Erde, Akademie der Wissenschaften der DDR, Berlin
International Vice Chairman:	Professor Dr. Sc. Jerzy Znosko Geological Institute, Warsaw, Poland
International Secretary:	Dr. Dietrich Franke Zentrales Geologisches Institut, Berlin, DDR
Danish Project Coordinator:	Dr. Olaf Michelsen Geological Survey of Denmark (DGU), Copenhagen
Swedish Project Coordinator:	Dr. Erik Norling Geological Survey of Sweden (SGU), Uppsala

Contents

page

Introduction 6
Outline of the geology of Scania (J. Bergström)........... 7
Pre-Cambrian and Palaeozoic tectonics of Scania (J. Bergström).. 21
Post-Palaeozoic tectonics of Scania (E. Norling & J. Bergström).. 28

Excursion localities:

1. Limhamn Quarry (B. Holland)........................... 49
2. Hardeberga (J. Bergström).............................. 55
3. Ö. Odarslöv (J. Bergström)............................. 59
4. Rönneberga backar (E. Norling)......................... 61
5. Rönnarp (K. Larsson)................................... 66
6. Gantofta (U. Sivhed)................................... 70
7. Bjärsjölagård (K. Larsson)............................. 72
8. Eriksdal (E. Norling).................................. 75
9. Komstad area (J. Bergström)............................ 82
10. Simrislund (J. Bergström)............................. 86

References... 88

INTRODUCTION

The 1982 meeting of the IGCP Project Tornquist is supplemented with two excursions, one of which is held in Scania, the southern extremity of Sweden. This guide-book was produced in order to facilitate for the excursion group to become acquainted with Scanian geology and with the excursion localities. It is not the first guide-book covering geology and localities in Scania. The one most widely in use is a guide to the Lower Palaeozoic prepared for the International Geological Congress in Copenhagen by Regnéll (1960). Although that guide is still very useful, the different scope of the Tornquist excursion and the comprehensive results of geological research and mapping since 1960 motivate this new summary.

The first part of the guide-book is a general description of the geology and tectonics of Scania and of the Bornholm Gat, which separates Scania from Bornholm. The last part is a description of excursion localities. A map showing the Phanerozoic geology and the excursion route is given in Fig. 1.

OUTLINE OF THE GEOLOGY OF SCANIA

Jan Bergström

Scania (Swedish: Skåne; German: Schonen) is the southernmost province of Sweden. As a result of the position on the edge of the Fennoscandian or Fennosarmatian Shield, Scania has had a complex geological history. Accordingly, the geological map shows a mosaic of different rocks at the bedrock surface (Fig. 1).

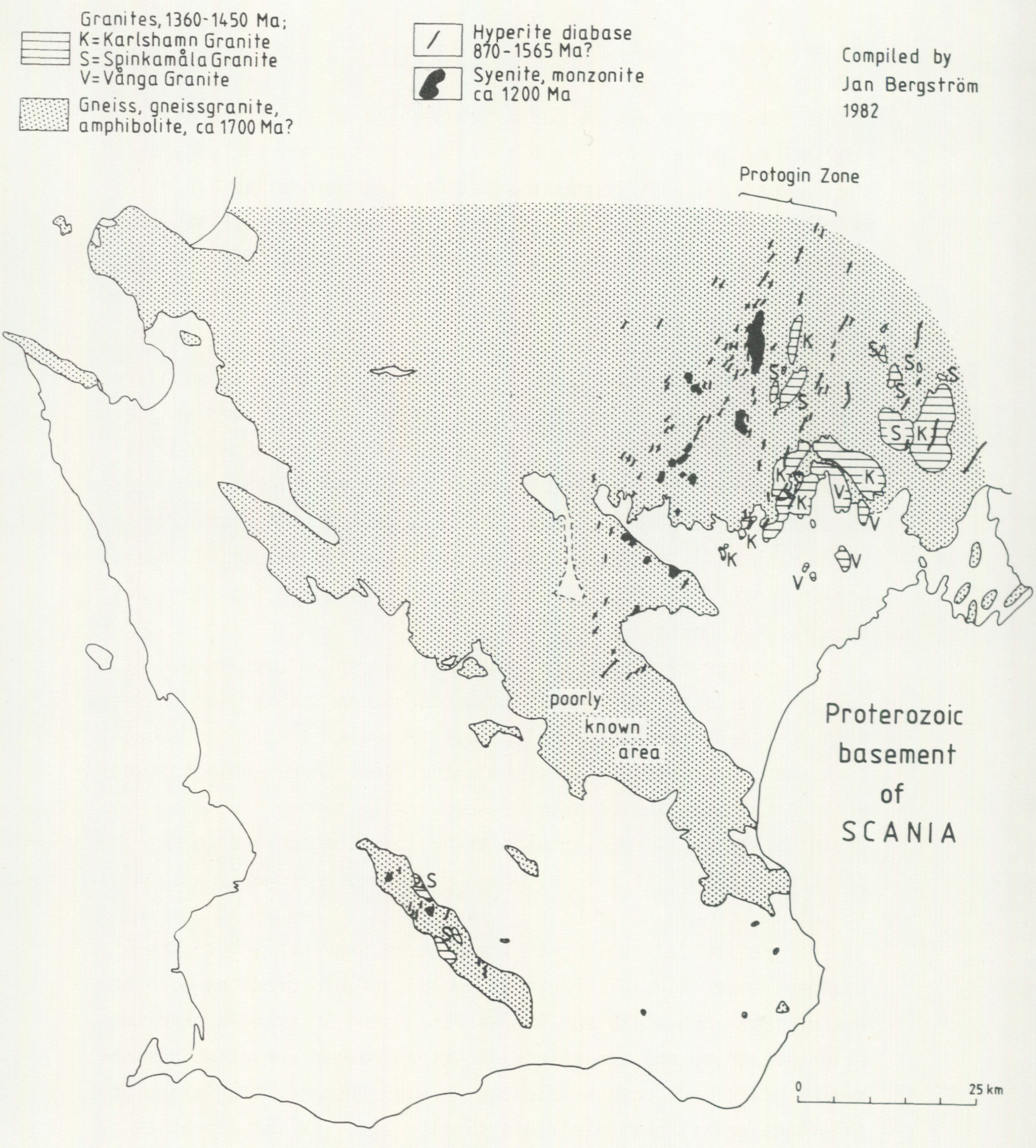
Basement rocks

In much of south Sweden there is a distinct north-south boundary zone (the Protogin zone, cf. Fig. 2) between the SW Swedish gneiss complex in the west and the Småland-Värmland intrusions and Småland porphyries in the east (Lundqvist 1979 for further references to this section). This boundary is less distinct in Scania, where SW Swedish gneisses merge with eastern province so called coastal gneiss (Kornfält, pers. comm.) and other rocks are less dominant than further north.

Well-preserved portions of the gneiss complex (metavolcanics) include the Västanå Quartzite in northeastern Scania. The gneisses also include amphibolite bodies, but the bulk is acid and thought to be metamorphosed granites and extrusives. There are also fine-grained granites presumed to be secondarily formed from the gneisses. There is no reliable dating, but the age has to be greater than that of the intruding granites, presumably around 1600–1700 Ma.

The granites all belong to the eastern province and to the boundary zone (Fig. 2). There is a group of old granites with an age of some 1350—1450 Ma. The Karlshamn and Spinkamåla granites belong to these and are coarse- to fine-grained varieties dominated by quartz and potash feldspar forming phenocrysts. Dating of the Vånga granite has yielded a similar age. The Vånga granite is dominated by microcline-perthite and quartz and has in addition some plagioclase, biotite and muscovite.

A group of younger intrusives include syenite, quartz syenite, monzonite, and probably hornblende granite (Fig. 2). A dating of



Compiled by
Jan Bergström
1982

Fig. 2. Basement rocks of Scania. After published sources and unpublished information from Sven Hjelmqvist, K.-A. Kornfält and Hugo Wikman.

a syenite has yielded an age of around 1185 Ma. In the same area there occur dike swarms of so called hyperite dolerites extended roughly N–S. The dating of these is somewhat difficult as there are apparently at least two generations. Whereas field relationships indicate one age between those of the Karlshamn granite and the syenite (i. e. roughly in the interval of 1350–1185 Ma), absolute dating has yielded 1565 Ma (unreliable) and 975–870 Ma.

Numerous dikes of so called northwest dolerite trend roughly WNW–ESE and indicate tensional movements in the Late Carboniferous or at the Carboniferous-Permian transition (Fig. 12).

A final magmatic event is indicated by the presence of basalt necks, most of which are found in central Scania. The basalts were long thought to be of Tertiary age. Radioactive dating has yielded various ages from the Jurassic to the Cretaceous (and Tertiary; Klingspor 1976). A basalt tuff has yielded microfossils reliably demonstrating an age around the Early/Middle Jurassic transition (Tralau 1973).

Cover rocks

The general pattern of geological boundaries, dolerite dikes and tectonic features is strongly dominated by a NW-SE trend (Fig. 1). This is the Tornquist direction. In the north the surface of the basement plunges gently towards the southwest and south in beneath the mainly Upper Cretaceous rocks of the Båstad and Kristianstad Basins (Fig. 10). The northern boundaries of these Cretaceous covers are caused by denudation, and numerous outliers and locally derived erratics indicate the former existence of a more widespread Cretaceous cover (Lidmar-Bergström 1982). The Cretaceous basins are fairly shallow, with a maximum depth in the south, where they are terminated against fault-lines.

These faults form the northeastern boundary in Scania of the vaguely defined Fennoscandian Border Zone (this term was coined by Sorgenfrei & Buch 1964), which in reality can be recognized as a major inversion axis (Ziegler 1975, Fig. 17).

In very generalized terms, the Fennoscandian Border Zone consists of a large block of basement gently tilted to the southwest (Figs 1,10). Thus basement rocks are exposed in a belt along the northeastern boundary. To the southwest follow Cambrian to Silurian strata, which in the northwest are overlain by Triassic and Jurassic rocks. Sediments of the latter ages are also found directly on the basement rocks, particularly in the northwest.

The tilted basement block extends to a line from Landskrona over Fyledalen to the southeastern tip of Scania. The southwestern boundary is formed by a section of the important Landskrona-Romeleåsen flexure and fault system and by the Fyledalen flexure and fault line. Southwest of the Fyledalen line is another basement block tilted in the opposite direction, viz. to the northeast (Figs 1,10). It is a matter of taste if this block is included in the Fennoscandian Border Zone or not. Its basement core is exposed in the Romeleåsen Horst, while the northeastern belt, the Vomb Basin, has a sequence of up to around 1000 m of Upper Triassic to Upper Cretaceous rocks lying directly on the basement. The Vomb Basin proper is terminated in the south by a fault system extending east from the southeastern tip of the Romeleåsen Horst. Southeast of this fault system the continuation of the Vomb Basin is still deeper.

The triangular part of Scania southwest of the Landskrona-Romeleåsen disturbance belongs geologically to the Danish-Polish Trough (Fig. 10). Here, the basement surface lies deeper than anywhere else in Scania. The greatest depth is found at the southwestern tip and is 2500 m. In the southwest the basement is overlain by up to 800 m of Cambrian to Silurian strata. Closer to the Landskrona-Romeleåsen disturbance the Palaeozoic is absent. The Mesozoic starts with Lower Triassic rocks in the southwest and with Upper Triassic in the northeast and ends with the uppermost Cretaceous. Much of the thickness (which measures some 1900 m at Höllviken in the southwest, Brotzen 1945, 1950) is caused by the up to 1200 m thick Upper Cretaceous strata. On top lies a comparatively thin sheet of Danian limestone, locally overlain by younger Paleocene and Eocene deposits.

The sedimentary sequence

Lower Palaeozoic

The Lower Cambrian is dominated by its basal formation, the quartzarenitic Hardeberga Sandstone. The thickness and variation is poorly known. However, in southeast Scania the thickness is estimated to around 115 m (Lindström & Staude 1971), and at Hardeberga close to Lund it is at least around 100 m (Regnéll 1960). The nomenclature of the formation is in a state of flux. In southeast Scania it has been called the Simrishamn Formation (Shaikh & Skoglund 1974) and even split into four formations (Lindström & Staude 1971). However, as correlation even inside Scania is difficult and as the

SERIES	STAGES AND ZONES			SCANIAN ROCK UNITS
Upper Cambrian	no stages	*Acerocare*		Alum Shale Fm
		Peltura		
		Leptoplastus and *Eurycare*		
		Parabolina spinulosa		
		Olenus and *Agnostus (H.) obesus*		
		Agnostus pisiformis		
Middle Cambrian	*Paradoxides forchhammeri* Stage	*Lejopyge laevigata*		
		Solenopleura brachymetopa		Andrarum Lst
		P. lundgreni and *Goniagn.nathorsti*		Alum Shale Fm
	Paradoxides paradoxissimus Stage	*Ptychagnostus punctuosus*		
		Hypagnostus parvifrons		
		Tomagnostus fissus and *Ptychagn.atavus*		
		Ptychagnostus gibbus		
	Eccaparadoxides oelandicus Stage	*Eccaparadoxides oelandicus* f. *pinus*		▨
		Eccaparadoxides insularis		
	Hawke Bay hiatus			
Lower Cambrian	no stages	*Proampyx linnarssoni* *Holmia kjerulfi* group		Gislöv Fm
		Holmia n.sp.		Rispebjerg Ss
		Schmidtiellus mickwitzi; Mobergella		Norretorp Fm
		Platysolenites antiquissimus	*"Rusophycus"*	Hardeberga Ss
			"Spirosolenites"	▨
		Sabellidites cambriensis		

Fig. 3. Cambrian stratigraphy of Scania.

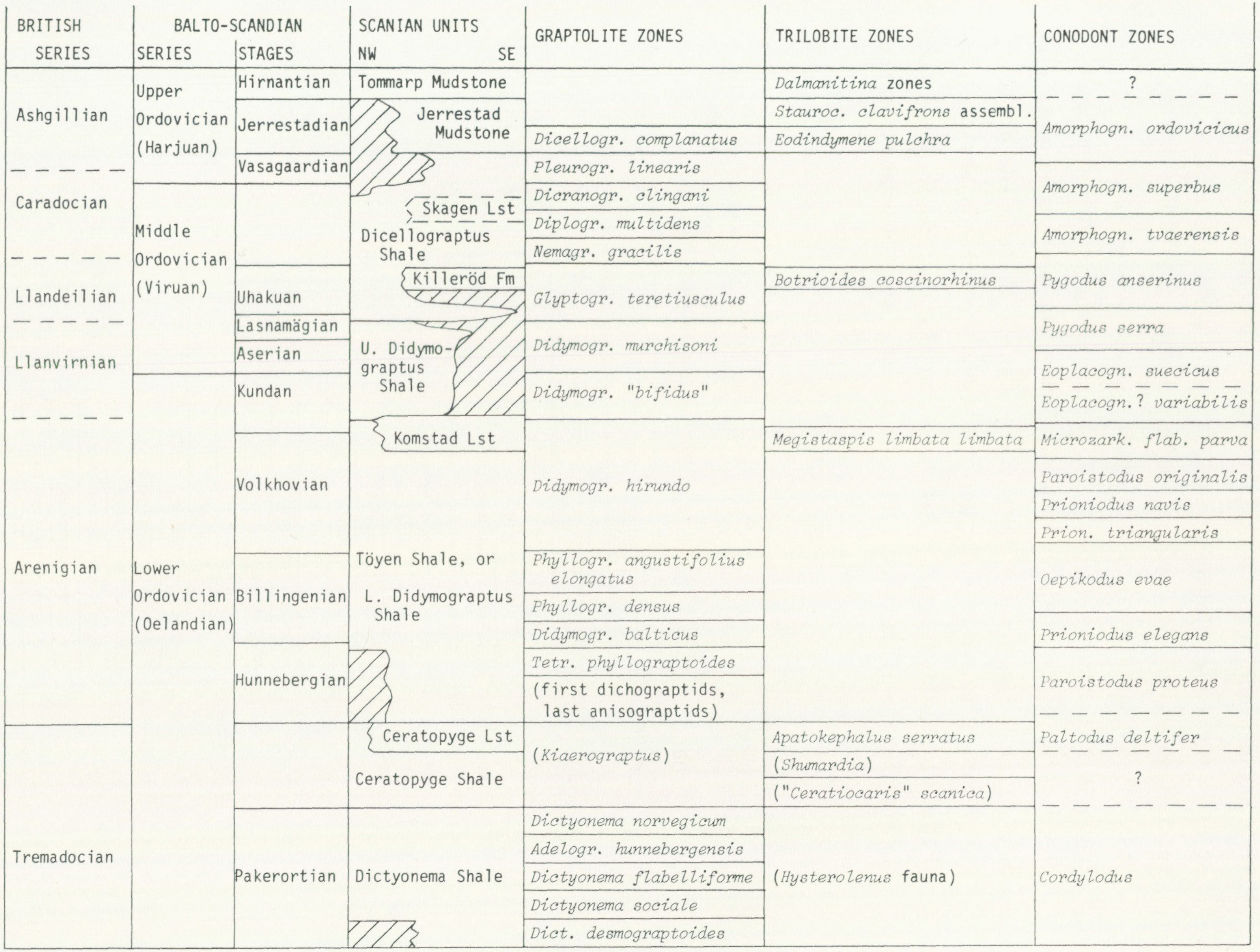
name Hardeberga Sandstone has priority, this name is preferred as a general formation name.

The lower part of the formation has not yielded any stratigraphically useful fossils, whereas the upper part contains trilobite type traces and acritarchs (e.g. Bergström 1981; Vidal 1981) indicating an early *Holmia* age.

The Hardeberga Sandstone is overlain by a fairly thin sequence (maximum 20 m?) consisting of the Norretorp, Rispebjerg and Gislöv Formations. The Norretorp Formation is more or less silty to sandy and contains glauconite, phosphorite and calcium carbonate. The Rispebjerg Sandstone is a highly phosphatic coarse sandstone, while the Gislöv Formation is dominated by shale, siltstone and limestone (Bergström 1970; Lindström & Staude 1971; de Marino 1980a; Bergström & Ahlberg 1981).

The Middle Cambrian is separated from the Lower Cambrian by a notable hiatus (Bergström 1981). The Middle and Upper Cambrian and the basal Tremadocian forms a fairly monotonous sequence of black kerogenous alum shale with kerogenous limestone (stinkstone) forming lenses and bands and a few levels of more pure limestone (Westergård 1942, 1944; Regnéll 1960). The thickness is around 20 m for the Middle Cambrian, 40–55 m for the Upper Cambrian, and 9–17 m for the Tremadocian alum shale, the Dictyonema Shale. The alum shale has aroused some interest because of its content of elements such as uranium and vanadium.

Most of the Ordovician above the Tremadocian Dictyonema Shale consists of shale with graptolites and shelly fossils. Mudstones are important in the Upper Ordovician. The 0–10 m thick Komstad Limestone forms a Lower Ordovician tongue of the Orthoceratite Limestone found in more northerly parts of Scandinavia and in the Baltic. It is underlain by some 25 m of Lower Didymograptus Shale (Tøyen Shale) and, directly on top of the alum shale, a thin Ceratopyge Limestone and Shale. The sequence above the Komstad Limestone is estimated at some 90 m (but seems to be much thicker in northwest Scania) and is referred to the Upper Didymograptus Shale, Dicellograptus Shale, Jerrestad Mudstone and Tommarp Mudstone (Fig. 4). For a summary of known facts see Regnéll (1960) and J. Bergström (1982). Important recent references include S.M. Bergström (1973), S.M. Bergström &



BRITISH SERIES	BALTO-SCANDIAN SERIES	BALTO-SCANDIAN STAGES	SCANIAN UNITS NW SE	GRAPTOLITE ZONES	TRILOBITE ZONES	CONODONT ZONES
Ashgillian	Upper Ordovician (Harjuan)	Hirnantian	Tommarp Mudstone		*Dalmanitina* zones	?
		Jerrestadian	Jerrestad Mudstone		*Stauroc. clavifrons* assembl.	*Amorphogn. ordovicicus*
				Dicellogr. complanatus	*Eodindymene pulchra*	
		Vasagaardian		*Pleurogr. linearis*		*Amorphogn. superbus*
Caradocian	Middle Ordovician (Viruan)		Skagen Lst	*Dicranogr. clingani*		
			Dicellograptus Shale	*Diplogr. multidens*		*Amorphogn. tvaerensis*
				Nemagr. gracilis		
Llandeilian		Uhakuan	Killeröd Fm	*Glyptogr. teretiusculus*	*Botrioides coscinorhinus*	*Pygodus anserinus*
Llanvirnian		Lasnamägian	U. Didymograptus Shale	*Didymogr. murchisoni*		*Pygodus serra*
		Aserian				*Eoplacogn. suecicus*
	Lower Ordovician (Oelandian)	Kundan		*Didymogr. "bifidus"*		*Eoplacogn.? variabilis*
Arenigian			Komstad Lst	*Didymogr. hirundo*	*Megistaspis limbata limbata*	*Microzark. flab. parva*
		Volkhovian	Töyen Shale, or L. Didymograptus Shale			*Paroistodus originalis*
						Prioniodus navis
						Prion. triangularis
		Billingenian		*Phyllogr. angustifolius elongatus*		*Oepikodus evae*
				Phyllogr. densus		
				Didymogr. balticus		*Prioniodus elegans*
		Hunnebergian		*Tetr. phyllograptoides*		*Paroistodus proteus*
				(first dichograptids, last anisograptids)		
Tremadocian			Ceratopyge Lst	(*Kiaerograptus*)	*Apatokephalus serratus*	*Paltodus deltifer*
			Ceratopyge Shale		(*Shumardia*)	?
					("*Ceratiocaris*" *scanica*)	
		Pakerortian	Dictyonema Shale	*Dictyonema norvegicum*	(*Hysterolenus* fauna)	*Cordylodus*
				Adelogr. hunnebergensis		
				Dictyonema flabelliforme		
				Dictyonema sociale		
				Dict. desmograptoides		

Fig. 4. Ordovician stratigraphy of Scania.

Nilsson (1974), Nilsson (1977, 1979) and Grahn (1978).

The Rastrites and Cyrtograptus Shales making up the Llandovery and Wenlock form a graptolite shale sequence with an estimated thickness of between 150 and 250 m (cf. Regnéll 1960). The succeeding unit, the Colonus Shale, is more than 600 m thick, possibly 800 or 1000 m according to some estimations. In contrast to the underlying parts of the Lower Palaeozoic, however, there is evidence that the Colonus Shale was never spread as a more or less homogeneous sheet over Scania. Instead the great thickness is found in a tectonic trough, the Colonus Shale Trough (Fig. 11). which apparently extended roughly in a NW–SE direction through Scania (Lindström 1960). Parts of this Silurian sequence

SERIES	ZONES	ROCK UNITS	
Downton	no graptolites in Scania	Öved Ss Bjärsjölagård Lst and Sh	Öved-Ramsåsa Group
Ludlow			
	Monogr. scanicus	Colonus Shale	
	Monogr. nilssoni		
Wenlock	*Monogr. ludensis*		
	Gothogr. nassa/M. dubius interregnum	Flemingi beds	Cyrtograptus Shale
	Cyrtogr. lundgreni		
	Cyrtogr. rigidus		
	Monogr. riccartonensis		
	Cyrtogr. murchisoni	Retiolites beds	
Llandovery	*Cyrtogr. lapworthi*		
	Monogr. spiralis		
	Monogr. griestonensis	Rastrites Shale	
	Monogr. crispus		
	Monogr. turriculatus		
	Monogr. sedgwicki		
	Cephalogr. cometa		
	Petalogr. folium		
	Monogr. gregarius		
	Monogr. revolutus		
	Rhaphidogr. extenuatus		
	Akidogr. acuminatus		
	Glyptogr. persculptus		

Fig. 5. Silurian stratigraphy of Scania.

have been described recently by Nyers & Nilsson (1973), Laufeld et al. (1975), Grahn (1978), and Nilsson (1979).

The uppermost part of the Silurian sequence is the Öved-Ramsåsa beds, which may measure a few hundred metres in thickness (cf. Regnéll 1960). The lithologies vary from limestones (Bjärsjölagård Limestone) to argillaceous and arenaceous beds. Red sandstones (Öved Sandstone) may be considered to represent Old Red facies and conclude the Palaeozoic sedimentary sequence. Correlation with ostracodes and conodonts (cf. Martinsson 1967, p. 380; Jeppsson 1974, p. 12) indicates that the Öved-Ramsåsa sequence spans the Ludlow-Downton boundary.

Mesozoic

Due to comparatively unstable conditions and more clastic sedimentation, the Mesozoic is much more variable in horizontal direction than is the Lower Palaeozoic. An outline of the sequence in and around Scania is presented in Fig. 6. Further details of the Triassic and Jurassic are found in Fig. 7, of the Cretaceous in Fig. 8, and of the Tertiary in Fig. 9.

The Lower and Middle Triassic are only represented in southwesternmost Scania, where these levels consist of arenaceous and argillaceous strata. The Upper Triassic has a much wider distribution in the southwestern half of Scania. The lower part, the continental Kågeröd Formation (thought to correspond to the Keuper), comprises up to 300 m of arkosic conglomerates, sandstones and montmorillonitic clays. It is overlain by a thinner Rhaetian sequence, including the Vallåkra Clay and the economically important Mine beds, consisting of kaolinitic clays and sandstones with two coal beds (Troedsson 1951; Norling & Skoglund 1977; Guy-Ohlson 1981).

Whereas the Triassic is confined to Scania southwest of the Kullen-Ringsjön-Andrarum tectonic line (Fig. 11), Jurassic rocks are found on both sides of this line, particularly in central and northwest Scania. The Jurassic is dominated by argillitic to arenitic clastics deposited in deltaic to marine environments. As is the case with the underlying Rhaetian, part of the Lower Jurassic has a cyclic development (Troedsson 1950, 1951; Norling

			DENMARK		SKÅNE except for Kristianstad area		BORNHOLM	
TERTIARY	Pliocene		clay and sand M					
	Miocene		micaceous clays and sands with lignite (M)	305				
	Oligocene		*m+k+i* clay and sand M	90				
			▨					
	Eocene		*m/i+k+i* Søvind Marl M	20				
			m+k+i Lillebelt Clay M	60				
			m+i+k Røsnaes Clay M	50				
			Mo Clay Formation M	50	mudstones	>5		
	Paleocene		*m* greensand and marl M	170	greensand and marl M	30		
		Danian	consolidated lst w. *flint* M	150	finegrained lst w. *flint* M	180		
			m+i bryozoan lst w. *flint* M		lst w. bryozoans and *flint* M			
CRETACEOUS	Upper Cretaceous	Maastrichtian	*m+i* chalk w. *flint* M	200	chalk w. *flint* and lst M	700		
			limestone and chalk M		lst w. sand and clay, ss, conglomerate M			
		Campanian		500		400		
		Santonian	marlstone and lst M	300	clayey lst, sandy and marly layers M	470	Bavnodde Greensand M	180
		Coniacian	limestone w. glauconite and *flint* M	150		100	▨	
		Turonian		50	lst w. *flint*, cgl M	75	Arnager lst w. some *flint* M	20
			dark shale M		▨		▨	
		Cenomanian	clay, marl and lst M	100	greensand, cgl, lst M	65	Arnager Greensand M	130
					▨			
	Lower Cretaceous	Albian	reddish marl and sand M		greensand M		▨	
		Aptian	*Q* sand, ss, clay and shale w. glauconite (incl. Skagen Formation) (M)	400	shale M			
		Barremian			shale and ss (M)			
		Neocomian			ss, sand, clay, shale, cgl F	120	grey clay w. sand and clayironst. F	250
							sand and gravel F	
JURASSIC	Upper		sand and ss w. glauconite (M)	275	variegated clays F	70	*i k* clay series F	
					quartz sand and ss F	40	gravelly sand and ss F	
					k variegated clays and marl F	145	▨	270
			claystone M					
	Middle		*Q* light grey to whitish ss (Haldager Formation) (F)	320	*k* quartz sand and silt F	30	*k+i* clay w. boulders of k-weathered granite, sand, coalseams F	
					sand and clay w. coal seams (M)	120		
	Lower (Lias)		*(Q)* dark claystone M	350	sh, clst, ss and ferrug. beds M	205	? ? clay and clayironstone ? ? M	100
					k variegated clays, coal, ss (M)	60		
					ss, siltstone, clay and marl M	170		
					k ss, clay, coalseams, ferruginous and calcareous beds (F)	200	*k* clay, sand and lignite F	350
TRIASSIC	Upper	Rhaetian	*Q* ss, coalseams (F)	200	*k+i* coal and clay (F)	50	▨	
			dark shale M		*m* Vallåkra dark clays (F)			
			green, limerich claystone	410	*m* red and green shales F	270	*m* red and green clays F	>70
			red and brown clay, dolomite, anhydrite (F)		red and green ss, arkoses cgl F			
	Middle		lst and marl w. dolomite and anhydrite M	180	grey ss and shales w. marly layers M	120	▨	
	Lower		red and brown ss, claystones, salt (F)	1280	red and green ss and sh F	40		
PERMIAN	Upper		lst, dolomite, anhydrite, salt M	1020	▨			
	Lower		red ss, volcanic ash (F)	260				

Fig. 6. Outline of the Mesozoic and Tertiary, excluding the Kristianstad area (after Lidmar-Bergström 1982). Figures show known maximum thicknesses in metres. When known, clay minerals are given in the upper left corner of each unit, dominant mineral listed first. m = montmorillonite, k = kaolinite, i = illite. Q means high quartz/feldspar ratio, (Q) fairly high quartz/feldspar ratio. Sedimentation conditions are indicated in upper right corner of each unit: M = marine, (M) = mainly marine, F = freshwater, (F) = mainly freshwater.

& Skoglund 1977). The thickness of the Jurassic is up to 1000 m. Marine fossils and sequences have recently been studied by several authors, including Norling (1970, 1972, 1981), Reyment (1959) and Sivhed (1977, 1980, 1981). Sporomorph biostratigraphy has been dealt with by Guy-Ohlson (1971, 1978, 1981).

The transition between the Jurassic and Cretaceous Systems is poorly dated due to the "Wealden" type of facies. The Lower Cretaceous, which measures some 200 m in south-westernmost Scania, is generally developed as sandstone and shale (Brotzen 1950; Norling 1970, 1981; Norling & Skoglund 1977). The uppermost part of the sequence tends to be glauconitic. Until recently, Lower

SYSTEM	SERIES	STAGE	SCANIA			NORWEGIAN-DANISH BASIN		
			FORMATION	MEMBER	ENVIRONMENT	FORMATION	MEMBER	ENVIRONMENT
CRET	LOWER		(Unnamed)	Vitabäck Clays	Limnic-brackish	Bream	Fredrikshavn	Brackish-marine
JURASSIC	UPPER	Portlandian						
		Kimmeridgian	Annero	Fyledal Clay	Brackish-marine		Børglum	
		Oxfordian		Fortuna Marl	Marine	Haldager	Flyvbjerg	Marine ↑ Non-marine
	MIDDLE	Callovian						
		Bathonian	NW. SCANIA Vilhelmsfält fm / SE. and W. SCANIA (Unnamed)	Glass Sand	Near shore		Haldager Sand	Deltaic-limnic
		Bajocian		"Eriksdal"	Deltaic-limnic			
		Aalenian	Rya	Rydebäck	Marine	Fjerritslev	F-IV	Marine
	LOWER	Toarcian					F-III	
		Pliensbachian		Katslösa			F-II	
		Sinemurian		Pankarp Döshult			F-I	
		Hettangian	Höganäs	Helsingborg	Deltaic-limnic			
TRIASSIC	UPPER	Rhaetian		"Mine beds" "Vallåkra beds"				
		Norian?	Kågeröd			Gassum		Deltaic-limnic

Fig. 7. Upper Triassic and Jurassic stratigraphy of Scania and the Norwegian-Danish Basin (Norling herein, after Norling 1972, 1981, Michelsen 1978 and Berthelsen 1978).

Cretaceous rocks were known only from southwest Scania, but Norling has now identified a Lower Cretaceous sequence also in the Kristianstad Basin in the northeast (Norling & Skoglund 1977; Norling 1981).

The Upper Cretaceous is much different. First, it is characterized by its strongly calcareous character. Secondly, tectonic movements have caused the accumulation of a thick pile of sediments, reaching a maximum of over 1100 m in southwest Scania (Brotzen 1950; Norling & Skoglund 1977). There is much variation in detail. In the Malmö area there is a dominance of limestone with an influx of clay and sandstone. The uppermost part consists of (Upper Maastrichtian) coccolith Chalk with flint concretions. In the Vomb Basin the sequence is less complete and is characterized by marlstone, sandstone and conglomerate (Lundegren 1935; Norling & Skoglund 1977). In the Kristianstad Basin the dominating rocks are biogenic limestones (calcarenite, calci-

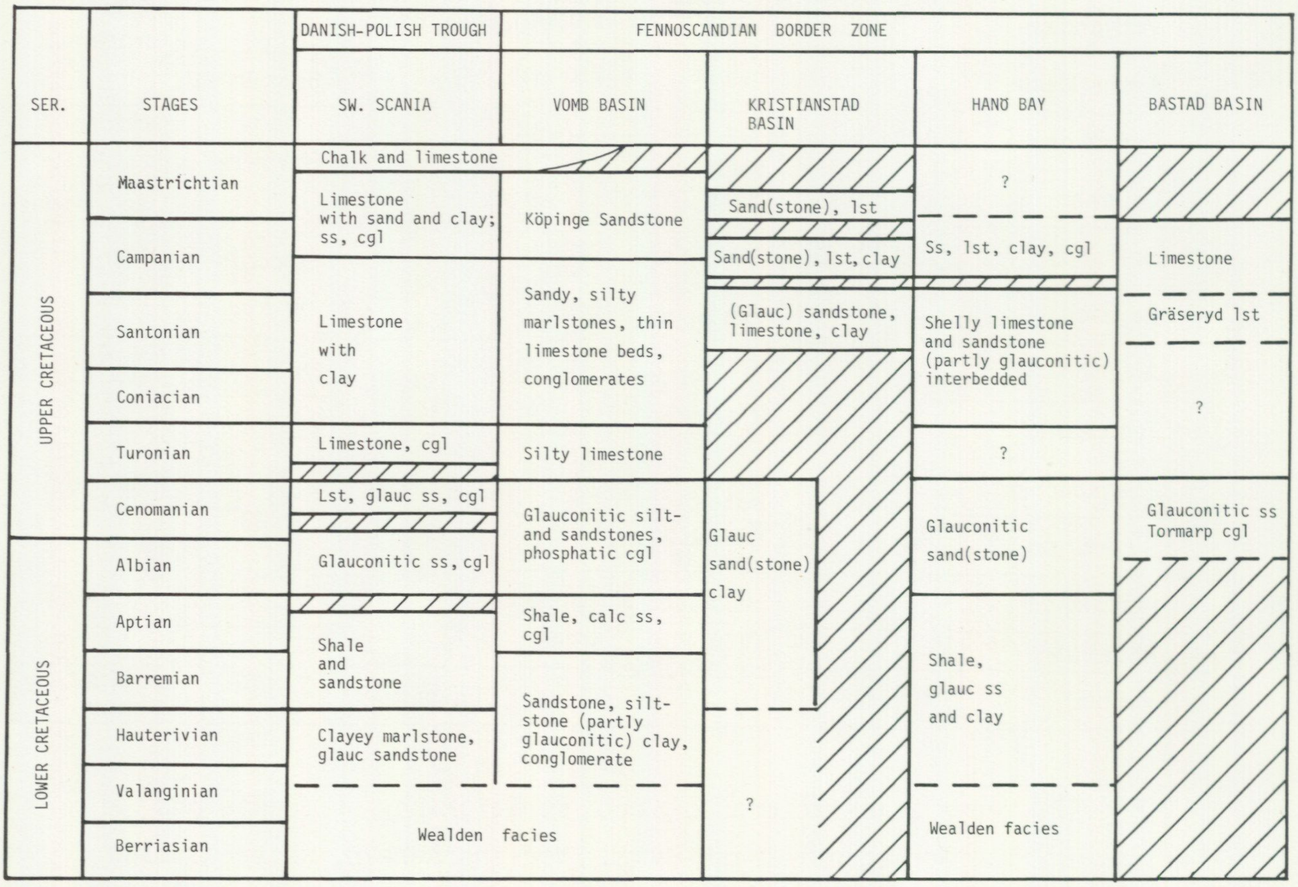


Fig. 8. Cretaceous stratigraphy of Scania.

SUB-SERIES	LITHOSTRATIGRAPHIC UNITS	MAX. KNOWN THICKNESS	ECHINOID SPINE ZONATION	PLANKTIC FORAMINIFERAL ZONATION	
Lower Eocene	Bosarp Mudstone	5 m		P6 *Morozovella subbotinae* & *Pseudohastigerina wilcoxensis* Z.	Remarks: Lowest records of *Pseudohastigerina* and *Globigerina* ex gr. *patagonica*
Upper Paleocene	Svedala Marl	15 m		P5 *Morozovella velascoensis* Z.	*Morozovella aequa* and *M. esnaensis* Subzones
				P4 *Planorotalites pseudomenardii* & *M. pusilla laevigata* Zone	
Middle Paleocene	Lellinge Greensand	15 m		P3 *Morozovella pusilla pusilla* & *M. angulata* Zone	
Lower Paleocene (Danian)	Danian Limestone	180 m (generally 60-65 m)	U. *Tylocidaris vexillifera* Zone	P1 *Globoconusa daubjergensis* Zone	P1c *Planorotalites compressa* Subzone
			M. *T. bruennichi* Zone		P1b *Subbotina triloculinoides* Subzone
			M. *T. rosenkrantzi* Zone		P1a *Subbotina pseudobulloides* Subzone
			L. *T. oedumi* Zone		

Fig. 9. Palaeogene stratigraphy of Sweden (Norling herein). Lithostratigraphic subdivision and foraminiferal zonation (post-Danian) after Norling (1973, 1978, 1980). Danian echinoid zonation after Brotzen (1959) and Danian foraminiferal zonation after Malmgren (1974). According to Holland & Gabrielson (1979) and Hansen (1977) various *Tylocidaris* species are restricted to particular facies. The *Tylocidaris* zones of Brotzen (1959) should thus be regarded as informally denoting lithostratigraphic units.

lutite with flint) and quartz sands and sandstones (Hessland 1950; Norling & Skoglund 1977; Kornfält et al. 1978). The quartz sand was sinnowed from kaolin weathered basement rocks, and as a consequence there are also deposits of kaolinitic clays. In addition, glauconite is common and also rock-forming at some levels.

The Danian (Fig. 9) is represented in the southwest by up to 180 m of finegrained white limestone with flint. Some limestones in the Malmö area are biohermal (Holland & Gabrielsson 1979). The Danian limestone is generally overlain by Quaternary sediments, but locally there is up to at least 35 m of post-Danian Paleocene and basal Eocene greensand, marl and mudstone (Brotzen 1948; Gustafsson & Norling 1973; Norling 1976, 1980). As far as is known, higher Tertiary levels are not represented by rocks in situ, but scattered finds of silicified wood indicate the possible (former?) presence of younger Tertiary rocks, possibly continental Oligocene-Miocene.

PRE-CAMBRIAN AND PALAEOZOIC TECTONICS OF SCANIA

Jan Bergström

Pre-Mesozoic tectonic events in Scania are poorly known. Pre-Cambrian surface levelling, Late Palaeozoic denudation and Mesozoic tectonic events have largely destroyed the evidence of older events.

Pre-Cambrian

The single most easily recognized pre-Cambrian tectonic structure is the wide N–S trending belt of shear zones sometimes recognized as the Protogin zone. Information on the structure and history of this belt is summarized by Lundqvist (1979, p. 53–57) and Lind et al. (1981). The zone separates the SW Swedish gneisses in the west from the Småland-Värmland intrusions, Småland porphyries, and Blekinge granites and gneisses in the east. The history is still poorly understood, but there is some agreement that the shear zone resulted from a large-scale uplift of the SW Swedish gneiss unit relative to the basement in the east. The dating is problematical. Dolerite dikes associated with the zone are supposed to date major faulting to around 900 Ma. On the other hand a 1210 Ma old syenite body reveals a pattern apparently controlled by the already existing zone. It is possible that the zone was active for a long time.

Other apparently tectonic structures in the basement include lineaments between areas with contrasting magnetic activity. Presumably such lineaments indicate faults. These are probably of pre-Cambrian age, but there is no prospect of a closer dating and the structures have not been subject to any particular study. There are also some magnetic lineaments through areas of a more homogeneous magnetic character.

Palaeozoic

The Cambrian sea obviously transgressed over a fairly stable area. Distortions of the sub-Cambrian peneplain thus mark later tectonic events. Throughout the Early Cambrian to Middle Silurian the sedimentation was monotonous, indicating fairly stable

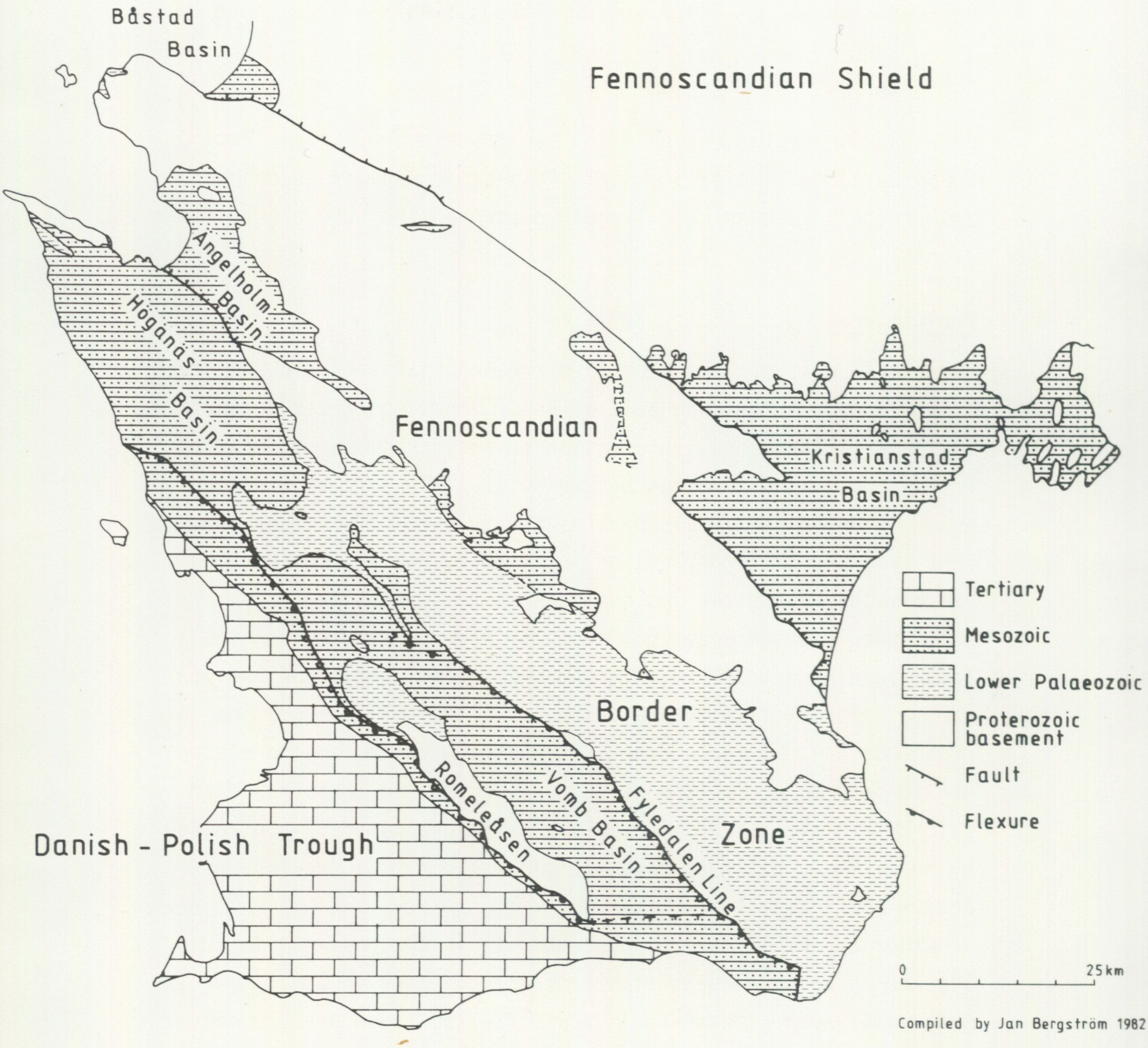


Fig. 10. Large tectonic and stratigraphic units of Scania.

conditions. However, the succession varies in completeness and thickness from one area to another (see e.g. S. M. Bergström & Nilsson 1974), and in the northwest the exceptionally thick Lower Ordovician indicates local sinking in the Early Ordovician. Lindström (1967) explained conical depressions in the Simrishamn area as caused by tectonic movements in the Cambrian.

In the early Late Silurian the Colonus Shale was deposited within a short time interval, corresponding to only one graptolite zone. The comparatively excessive thickness (800 m??) indicates rapid sinking. Lindström (1960) has presented evidence for sediment transport from the NW or W in an elongate sinking trough.

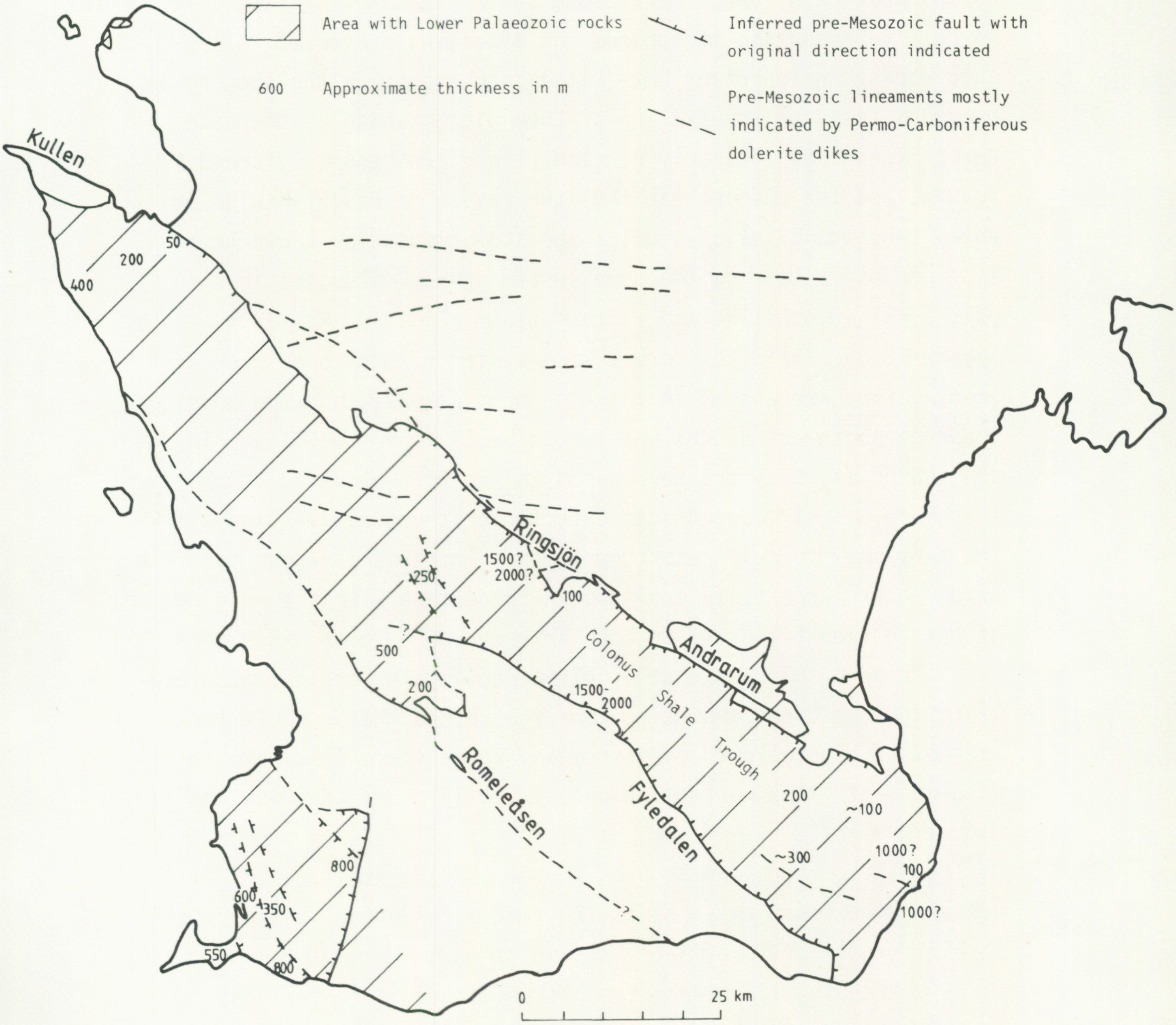


Fig. 11. Lower Palaeozoic sedimentary rocks below Quaternary and Mesozoic cover and tectonic features of pre-Mesozoic age. Fault directions tend to be opposite to what was found along the same fault-lines in the Mesozoic.

This trough was called the Colonus Shale Trough. It appears likely that the Kullen-Ringsjön-Andrarum fault system formed the northeastern boundary of the trough (Fig. 9). The southwestern boundary may have been formed by the Romeleåsen Fault, possibly in combination with the Fyledalen Fault, but the age of these two faults is somewhat questionable.

The absence of Upper Palaeozoic sediments makes it difficult to date sub-Mesozoic structures not affecting preserved Palaeozoic rocks. An important Late Palaeozoic event was the opening of numerous fissures and filling of them with diabase in the Late Carboniferous and/or Early Permian. The dikes generally trend NW to WNW, and the opening was thus the result of roughly SW—NE oriented tension. Dikes of similar age and orientation known from Scotland may belong to the same system as may dolerites in the Oslo area, in Bohuslän and Västergötland (Fig. 10; Russel & Smythe 1978). The dikes form a wide system present over much of Scania. They are absent in the extreme northeast, and the possible presence southwest of the Romeleåsen Fault is not verified. In the southeast, they are terminated in the Bornholm Gat, which therefore was already an active tectonic structure, leading off the tensional forces present in Scania. There is no known positive evidence of large-scale faulting in connection with the opening of the tension fissures. On the contrary, where both sides of a dike are seen there is mostly only a negligible vertical displacement, in some cases amounting to a few metres. Major fault lines are mostly not followed by dikes, and where there is a notable displacement, this can not be unequivocally connected with the magmatic event.

The dike pattern can be used to demonstrate fractures of divergent directions existing at the time of eruption in the Late Carboniferous/Early Permian. As seen in Figs 9 and 10 a number of E—W trending lineaments are distinguished in central and northern Scania by this method. Northwest of Ringsjön the dike pattern reveals the pre-existence of parallel faults in the Kullen-Ringsjön-Andrarum fault system. When studied in detail, the E—W lineaments are much more common than indicated by the map.

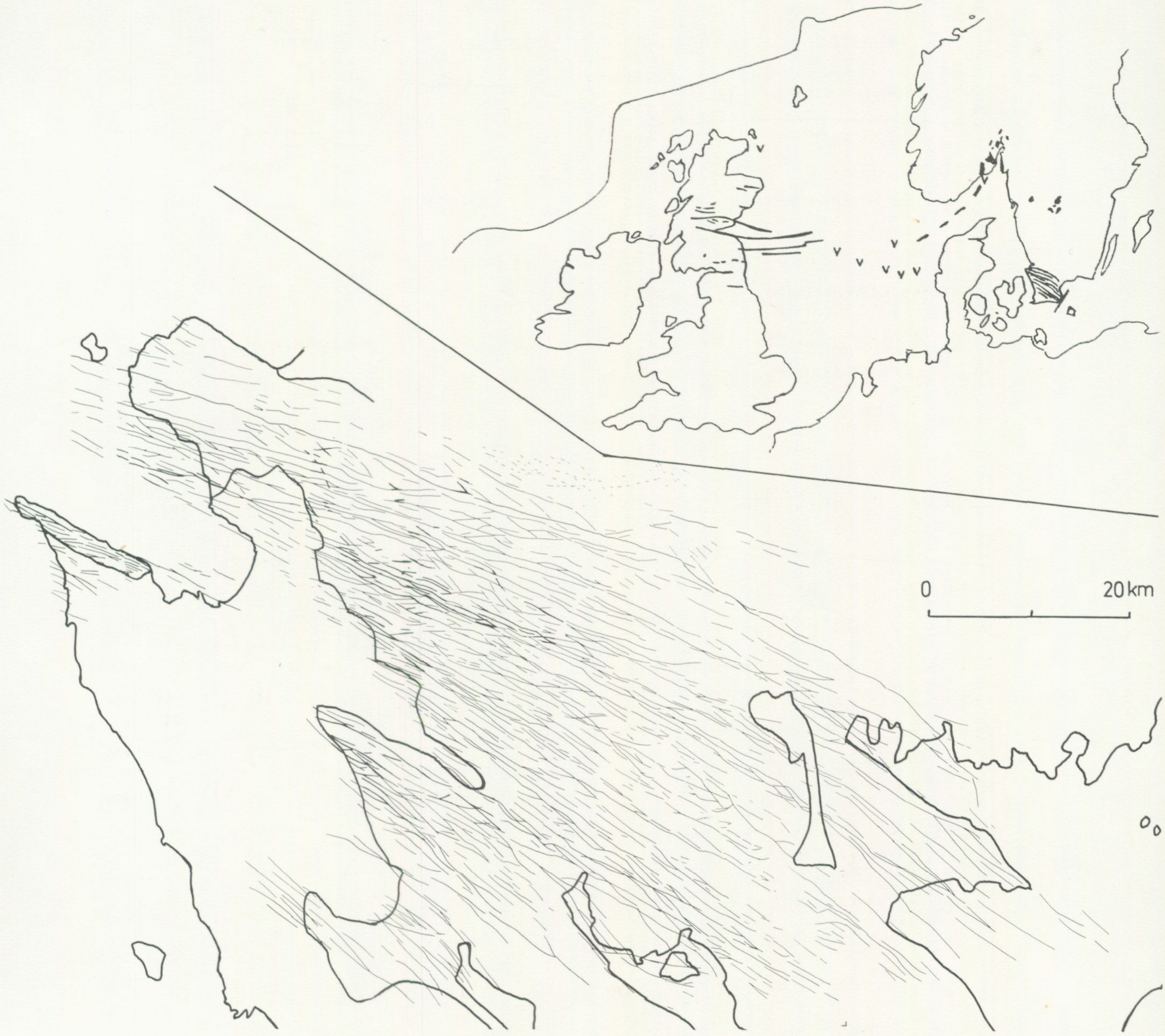


Fig. 12. Pattern of Permo-Carboniferous dolerite dikes in northern Scania. Boundary between pre-Cambrian to Lower Palaeozoic rocks penetrated by dikes and Mesozoic to Cenozoic cover indicated (some dikes also indicated under a thin cover of Mesozoic rocks). Small map (modified after Russel & Smythe 1978) shows distribution of Permo-Carboniferous igneous rocks in northern and northwestern Europe.

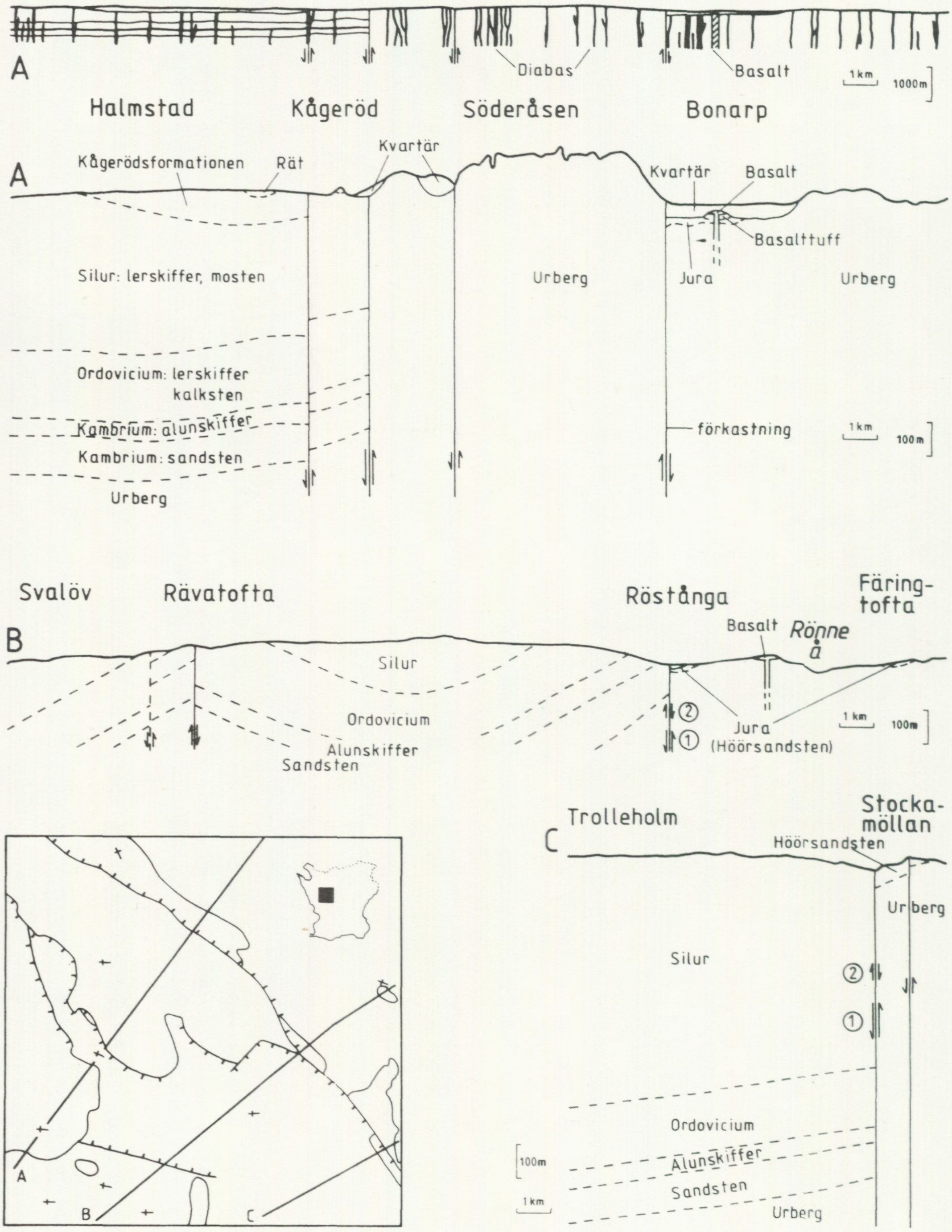


Fig. 13. Sections through the Kullen-Ringsjön-Andrarum tectonic line in northwestern Scania. Top illustration shows abundance of Permo-Carboniferous dolerite dikes. Profiles B and C indicate primary sinking (1) of the southwest side along faults in the Silurian(?) and small reverse movements (inversion) in the Jurassic (2).

Particular structures are dated to the Palaeozoic (and/or to the early Mesozoic) by overlying strata. Lower Triassic beds are found only in the southwest, and successively younger Mesozoic strata overstep the Palaeozoic and basement towards the northeast. The Palaeozoic is absent between the Romeleåsen Fault and the Fyledalen Fault (i.e. on the Romeleåsen-Vomb Block) and directly west of the Romeleåsen Fault. Obviously these areas were uplifted and subject to denudation prior to the Triassic-Jurassic sedimentation. At least the Fyledalen Fault was active in this event, and if the Romeleåsen-Vomb Block was part of the older Colonus Shale Trough the movement may be considered as an inversion movement. The northwestern end of the raised Romeleåsen-Vomb Block had a prolongation in the narrow Eslöv Uplift, where post-movement denudational levelling exposed Middle Ordovician strata, contrasting with the surrounding surface of Silurian shales before Kågeröd beds covered the area in the Late Triassic. Vertical movements amounted to some hundred metres (Troedsson 1942).

In southwest Scania Late Palaeozoic vertical movements amounting to some 500 m occurred along the Svedala Fault. The Palaeozoic preserved west of this fault was dissected by NNW-trending Palaeozoic movements along NNW-trending fault lines, as demonstrated by the relationship to the overlying Lower Triassic strata.

Lindström (1960) described NW-SE-trending compressional folds in Silurian shales of Scania. The folds were thought to be pre-Mesozoic in age.

Finally, it is important to remember that the sub-Mesozoic surface of Scania was the result of considerable general uplift and immense denudation. Denudation had completely removed every trace of the superficial effusives which must have resulted from the Late Carboniferous/Early Permian magmatic event. At the same time all possible Upper Palaeozoic sediments disappeared, and the Lower Palaeozoic strata were completely removed from much of the area and reduced in other parts (Fig. 11).

POST-PALAEOZOIC TECTONICS OF SCANIA

Erik Norling and Jan Bergström

Introduction

The major Late Palaeozoic post-orogen fracturing of NW Europe, responsible for the collapse of the Variscides, also affected Scania. This period of tectonic activity resulted in northwest-southeast striking dike swarms dated by radiometric methods to Late Carboniferous-Early Permian (Priem et al. 1968, Klingspor 1976). During this period the block tectonics characterizing the Fennoscandian Border Zone in post-Palaeozoic times were initiated. Further to the west the Ringköbing-Fyn High began to rise in Early Permian time, its margins being marked by gentle flexures rather than major faults. In between the Fennoscandian Border Zone and the Ringköbing-Fyn High, the Danish-Polish Trough began to subside. In late Palaeozoic time the boundary between the Fennoscandian Shield and the Danish-Polish Trough was situated southwest of Scania. In post-Palaeozoic times, however, this boundary moved towards the northeast and occupied various positions within the Fennoscandian Border Zone. This zone has been subject to major tectonic activities during various phases of the Saxonian tectogenesis.

Pre-Kimmerian tectonics (Triassic) - EN

Although the Triassic is regarded as a tectonically quiet period, Triassic synsedimentary movements lead to a major subsidence of the Danish-Polish Trough. In its central part several kilometres of Triassic sediments have been recorded (in Gassum-1 and Rønde-1, east Jutland c. 2 km).

Early in the Triassic SW Scania was included in the Danish-Polish Trough, whereas other parts of the province remained denudation areas. The SSW—NNE directed Trelleborg-Svedala Fault and the WNW—ESE trending Malmö Fault formed already in Palaeozoic times, were obviously active during the Triassic (Fig. 14; cf. Fig. 11). West

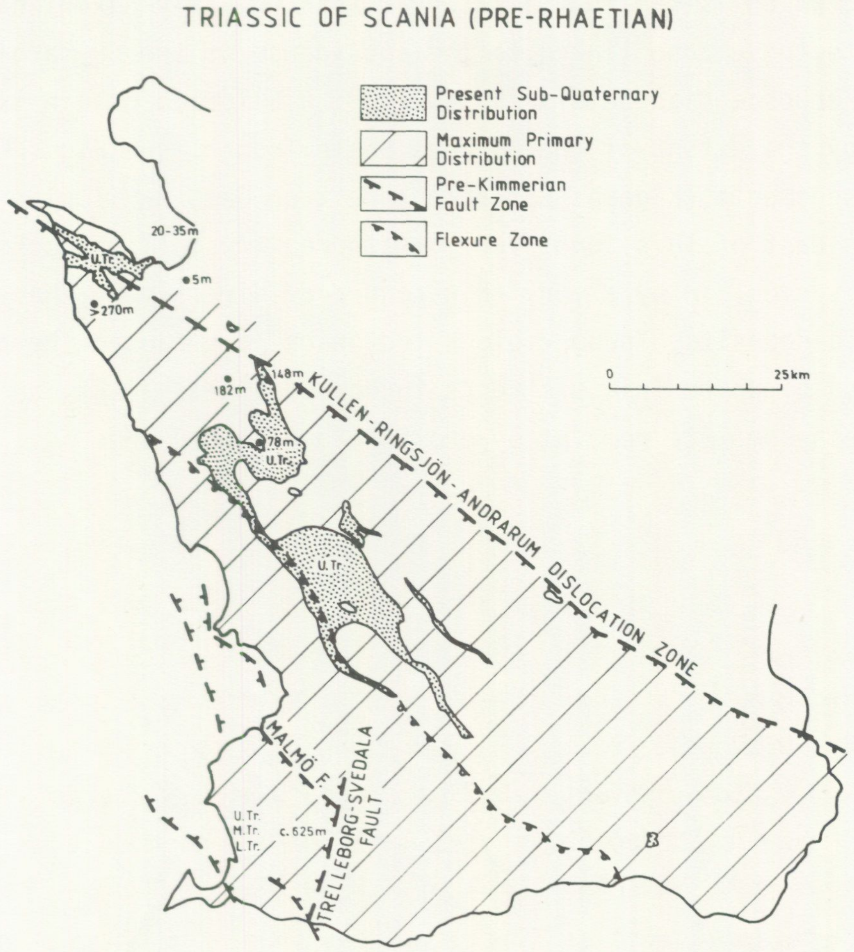


Fig. 14. Triassic of Scania. Distribution of sedimentary rocks and main tectonic trends.

respectively south of these faults the sedimentary sequence includes Lower and Middle Triassic strata, which have not been recorded from other parts of Scania. The oblique Triassic sequence of SW Scania, including also the Upper Triassic, rests on Lower Palaeozoic strata and basement rocks and is succeeded by more or less horisontal Jurassic-Cretaceous beds.

In Late Triassic time the eastern boundary of sedimentation moved further towards the north-east in Scania. This boundary can be traced along a major dislocation zone traversing Scania from north-west to south-east. Its northwestern section has been named the Kullen-Brantastig-Ringsjön dislocation zone. To include the southeastern prolongation, the name is here modified to the Kullen-Ringsjön-Andrarum dislocation zone (Fig. 14). South-west of this zone, which is regarded a Late Variscan or Early Saxonian synthetic tectonic zone linked to the subsidence of the SW margin of the Fennoscandian Shield (Bölau 1973; a Silurian origin is indicated by the extent of the Colonus Shale Trough, see Fig. 11), Keuper sediments (Kågeröd Formation) rest on Cambro-Silurian rocks. North-east of this zone deeply weathered crystalline rocks occur, partly overlain by a very thin Keuper or directly by Rhaetian-Jurassic deposits. Younger block tectonics have caused the preservation of Upper Triassic rocks in down-faulted blocks, or a more or less complete removal by erosion in uplifted ones.

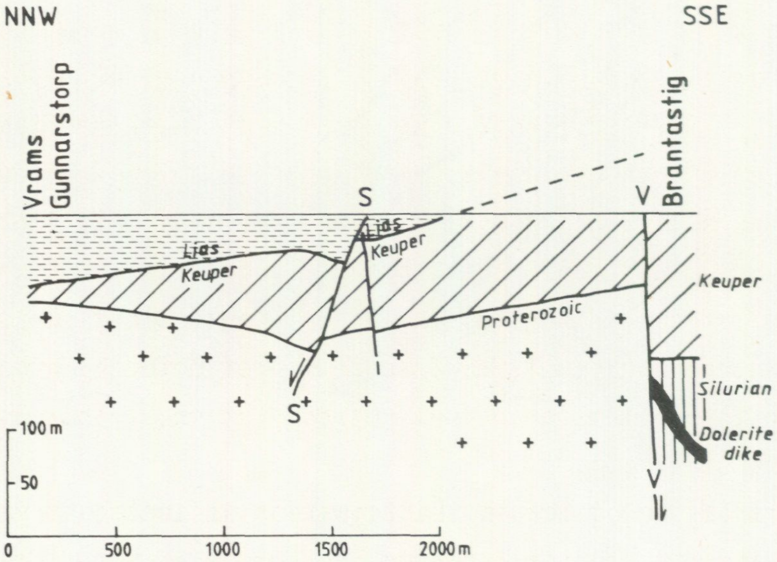


Fig. 15. Schematic section traversing the Kullen-Ringsjön-Andrarum dislocation zone (see Fig.14) showing Variscan (V) and Saxonian (S) faults. (Redrawn from Bölau 1973).

Kimmerian tectonics (Rhaetian-Jurassic/earliest Cretaceous)

At the end of the Triassic, in Rhaetian time, Scania was subject to major climatic changes. Bright-coloured, green and red sandstones, arkoses and clays of the Kågeröd Formation, regarded of arid origin, were succeeded by predominantly dark coloured sandy and clayey layers of Rhaetian age indicating humid conditions. The latter climatic environment favoured a deep kaolinization of the crystalline basement framing the Rhaetian sedimentary trough. This weathering might have been of importance for the initiation of new areas of sedimentation. The kaolin content gives the Upper Rhaetian clays excellent ceramic properties, which is also true of some Jurassic clays, viz. the Upper Sinemurian Pankarp Clays and the Oxfordian-Kimmeridgian Fyledal Clay.

In Rhaetian time started a new period of tectonic activity of major importance in the structural history of Scania, viz, the Kimmerian tectonic phase. This term is used here in the sense of Stille (1924, p. 131). It is thus regarded as the pre-Cretaceous phase of the Saxonian tectogenesis. During the Kimmerian phase the characteristic horst structures of Scania were initiated and became still more pronounced by later tectonic activities.

Among those who have discussed the Kimmerian movements of Scania Nathorst (1887), Voigt (1930), Troedsson (1940, 1942, 1951) and Bölau (1951-1975) should be mentioned. The Kimmerian structural development of Scania coincides with a long period of sedimentation following a cyclic pattern. The sedimentation was, however, by no means continuous throughout the distribution area of Rhaetian-Jurassic deposits. Individual fault blocks were repeatedly downthrown and uplifted, which is reflected by great variations in their stratigraphical representation, lithology and thickness of strata.

The major importance of the Kimmerian tectonics is naturally most obvious in areas without an overburden of Upper Cretaceous and Palaeogene deposits. Such areas are to be found in northwest, west and central Scania (including the Vomb Basin). Figs. 1, 16).

For the interpretation of Kimmerian movements NW Scania must be one of the most suitable areas. This is due to the over two centuries long tradition of mining Rhaetian-Liassic coal and fireclays. The mining documentation includes e.g. isopach maps of the coal-bearing formation (Höganäs Formation, Fig. 7) showing variations in thickness and depth, as well as petrographical data of the rocks.

As mentioned above, NW Scania is traversed by part of the pre-Kimmerian Kullen-Ringsjön-Andrarum dislocation zone. West of

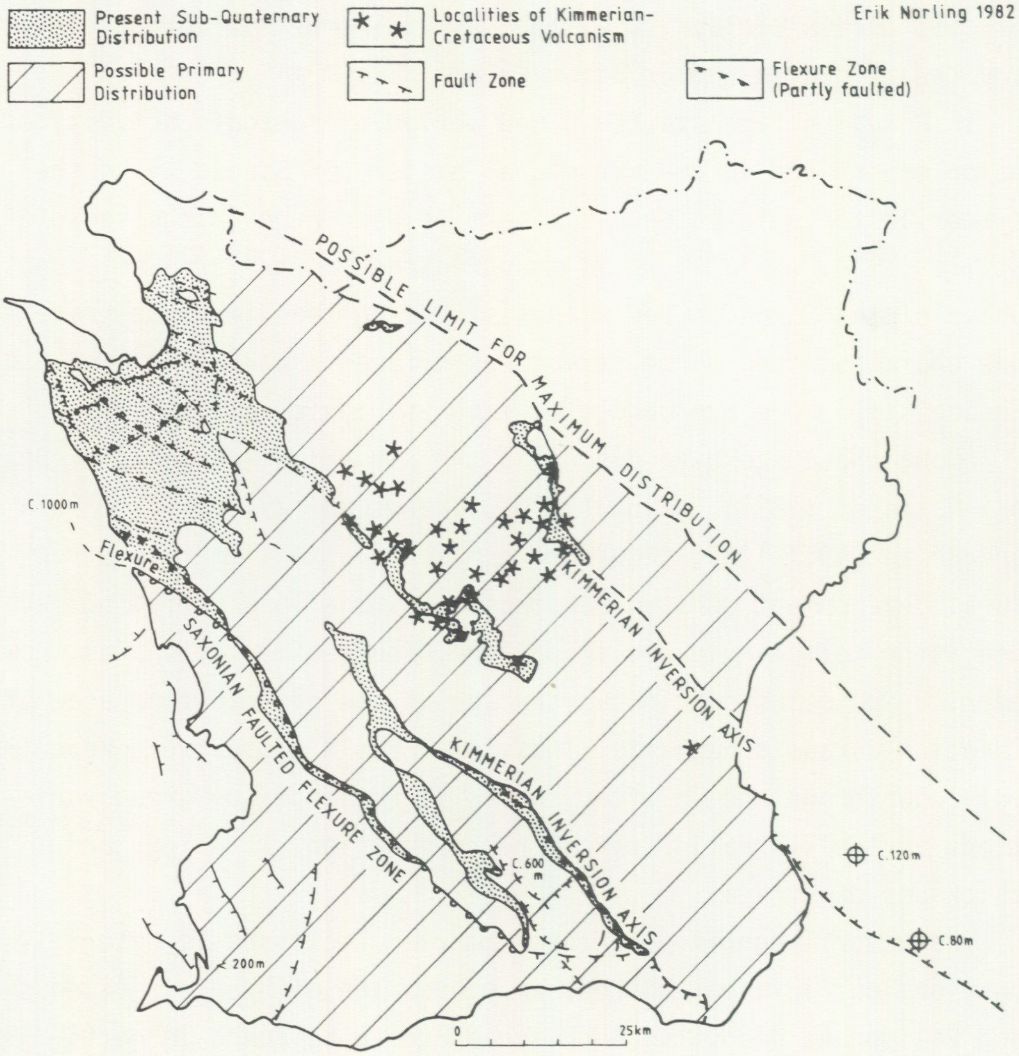


Fig. 16. Map of Scania showing sub-Quaternary distribution of Rhaetian and Jurassic rocks and main Kimmerian tectonic lineaments.

this zone the so-called western Söderåsen-Kullen area is characterized by 4—6 km broad antithetically tilted blocks trending NW—SE. The Rhaetian-Jurassic deposits in this area rest on a fairly thick sequence of Lower Palaeozoic and Upper Triassic rocks. A regional westward downwarping of the tectonic blocks has resulted in successively thicker deposits in the direction of the Danish-Polish Trough. The formation of a "trough" more or less perpendicular to the NW—SE tectonic direction complicates the pattern. This transversal trough, named the Viken-Vilhelmsfält trough by Bölau (1959), was subsiding during the Rhaetian and onwards throughout the Early Jurassic. (Fig. 17, Viken-Vilhelmsfält transverse trough).

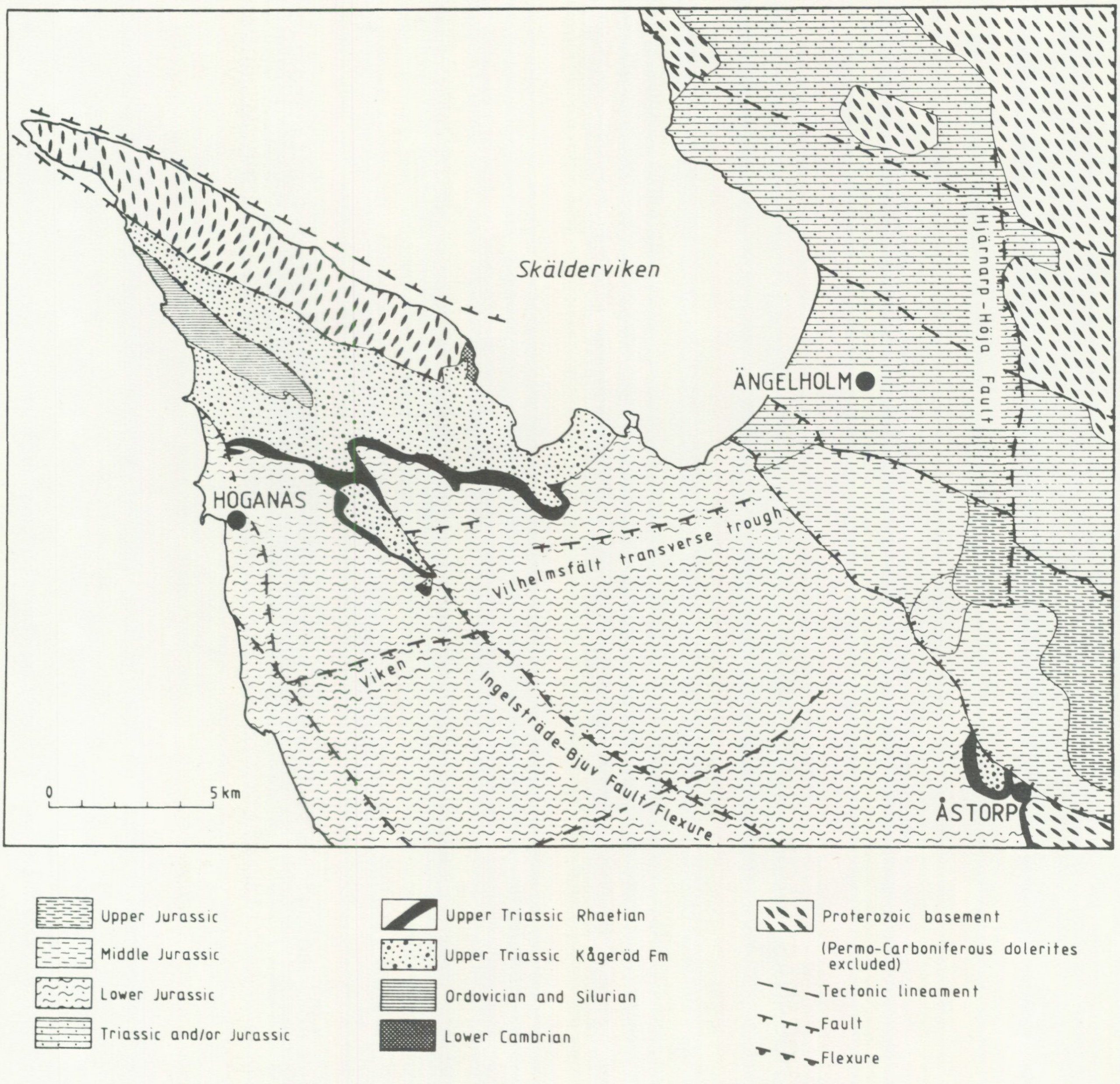


Fig. 17. Geological sketch map of NW Scania (After Wikman, Norling, Sivhed & Karis 1981). For dolerites see Fig. 12.

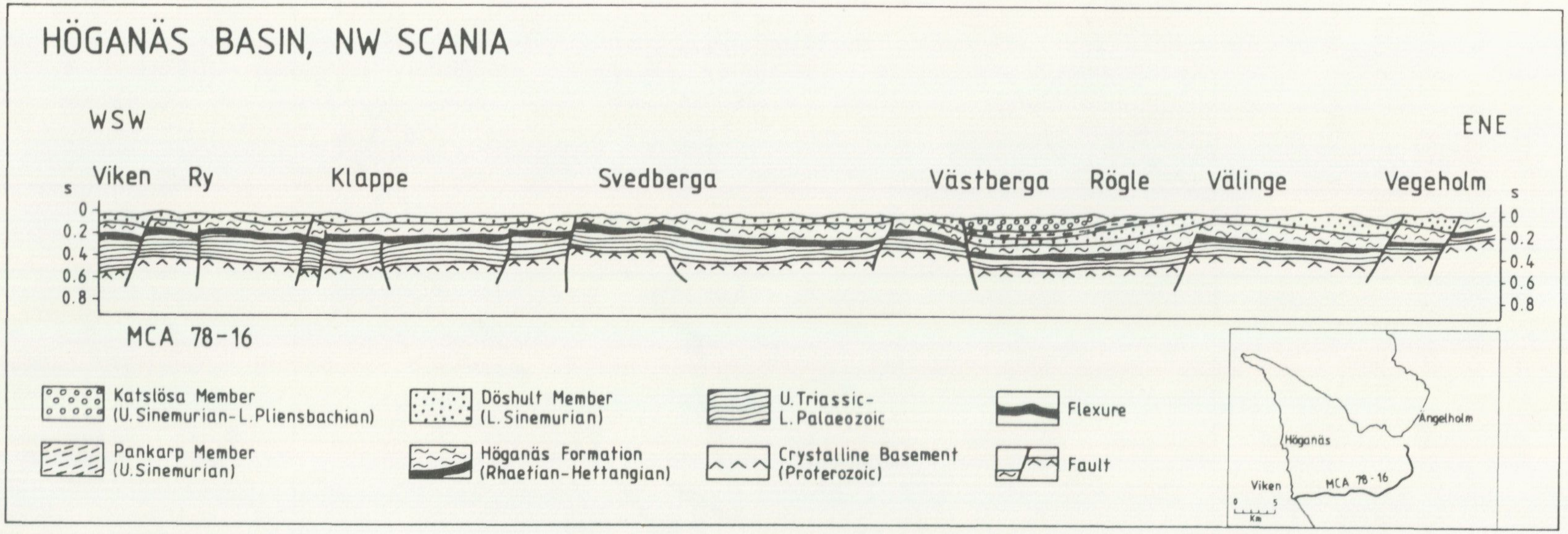


Fig. 18. Geological section traversing NW—SE trending Saxonian faults and flexures. Based on reflection seismic profile. Höganäs area, Fennoscandian Border Zone, NW Scania (height scale in seconds two way time).

Northeast of the dislocation zone mentioned above the so called eastern Söderåsen-Hallandsåsen area represented quite another environment for the Rhaetian-Jurassic sedimentation and exhibits also a somewhat different character of tectonic movements. In this area the Rhaetian sediments were laid down directly on deeply kaolinized crystalline rocks. The Jurassic sequence exhibits major stratigraphical gaps, but contrary to the western Söderåsen-Kullen area it includes also Middle and Upper Jurassic strata (Figs 17, 19).

Early Kimmerian tectonics (Rhaetian-Early Jurassic)

According to Bölau (1973) the Early Kimmerian movements in Scania represent an epeirogenic prelude to a later orogenic structural phase. There are no indications of Early Kimmerian orogenic disturbances, which among other things mean that the formation of horst structures, such as Söderåsen and Kullen, must be of a younger age. The source of clastic material in the NW Scanish Rhaetian-Early Jurassic basins was an uplifted area northeast of the Kullen-Ringsjön-Andrarum dislocation zone. This denudation area included the present Söderåsen and Kullen, the bordering faults of which, however, did not exist in Early Kimmerian time.

Faults have been observed in the Rhaetian coal-fields at Höganäs, Nyvång and Skromberga west and north-west of Söderåsen. Their displacements are, however, so slight that they can hardly be regarded as epeirogenic structures (Bölau 1973). The development of the Rhaetian sedimentation appears to have been fairly quiet and undramatic. The tectonics of this time seem to have been restricted to the initiation of epeirogenic structures. The Early Kimmerian movements in Keuper/Rhaetian time are characterized by a regional westward down-warping towards the Danish-Polish Trough. Formation of flexures occurred along lineaments, which in some cases later became faulted to real orogenic structures (Fig. 18).

Several observations of intra-Liassic discordances indicate an increased tectonic activity in the Early Lias. The deposition during the Hettangian of coarse arkosic sandstones in between more fine-grained deposits may also be seen as an indication of

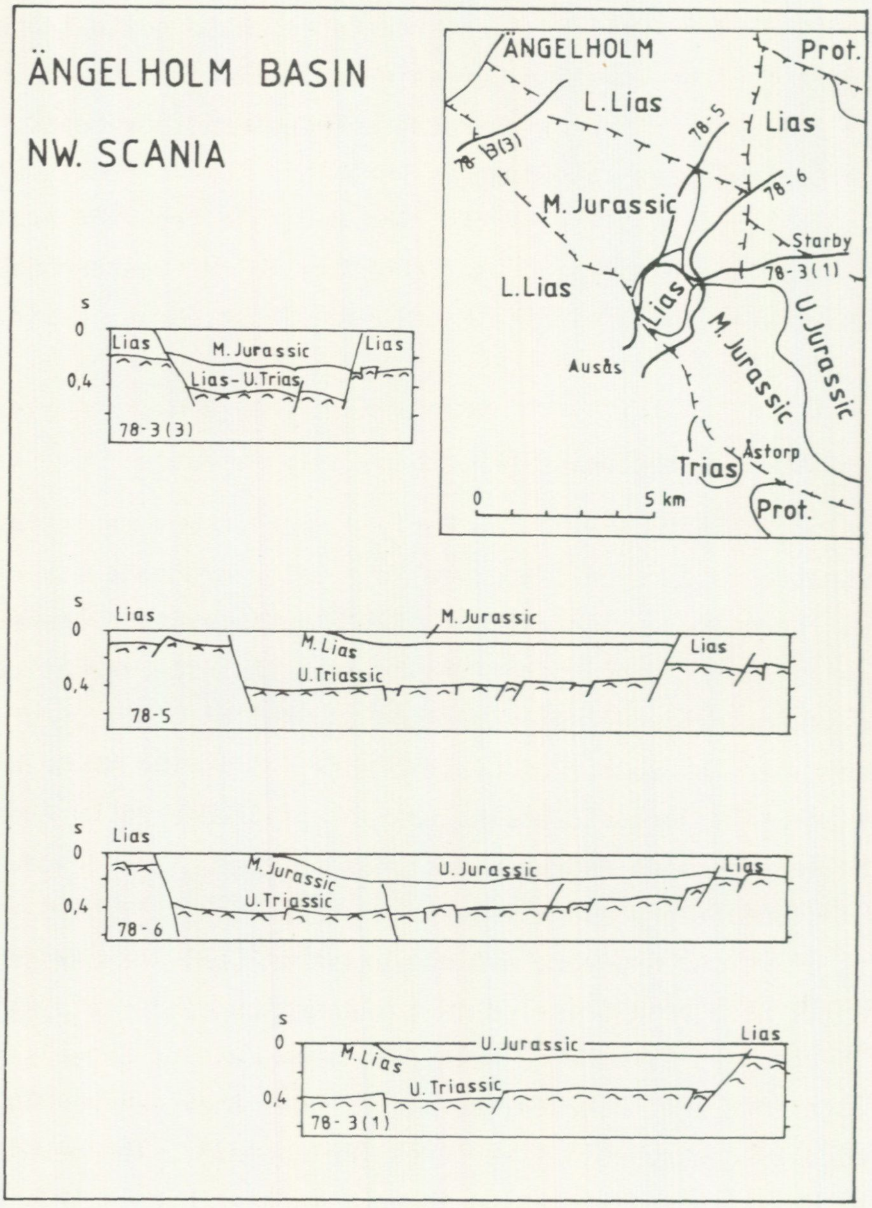


Fig. 19. Cross sections of the Ängelholm Basin, Fennoscandian Border Zone, NW Scania. Based on reflection seismic profiles (height scale in seconds two way time).

tectonic activity (e.g. Boserup, Halalid and Fleninge sandstones). Obviously, more or less sudden movements in the earth's crust gave rise to new delivery areas of coarse clastic material. Borings along the western side of Söderåsen have penetrated Hettangian breccias, evidence of fairly abrupt tectonic activity. Actually, several observations indicating earthquakes and major crustal movements have been made in Liassic (and Middle Jurassic) strata framing Söderåsen. These observations may indicate a late Early to Mid-Kimmerian initiation of the Söderåsen horst structure.

After a period of mainly continental-deltaic sedimentation in Rhaetian-Hettangian time several marine transgressions invaded Scania during the Lias. These transgressions were connected with an increased tectonic activity. At the end of the Lias, in Late Toarcian time, the south-west margin of the Fennoscandian Shield was uplifted and a long period of marine sedimentation was replaced by a continental interval.

Mid-Kimmerian tectonics (Middle Jurassic)

During the major part of the Middle Jurassic Scania was uplifted and isolated from the sea. In some parts of the province, viz. in western Scania, the Ängelholm area, Central Scania, and the Hanö Bay, sedimentary troughs continued to subside under the burden of limnic and brackish deposits. In other parts of the province Liassic sediments were subject to erosion.

In NW Scania the Ängelholm Basin between Söderåsen and Hallandsåsen resulted from Mid-Kimmerian and Late Kimmerian movements. During the Lias individual blocks within the basin had risen respectively subsided, which is obvious from various stratigraphical gaps observed in bore-holes. The fault along the northeastern side of Söderåsen has a displacement of several hundred metres and it seems likely that the horst character of Söderåsen became pronounced already in Middle Jurassic time (Figs 17, 19).

Comparisons between the Ängelholm Basin and the Höör-Ringsjön area further towards the south-east, as to Rhaetian-Jurassic stratigraphical representation and lithology, demonstrate a striking agreement. It is obvious that the sequences of these two areas were deposited in a common sedimentary basin. Nowadays, however, there is a major crystalline uplift between the two areas, with only scattered remnants of Rhaetian-Jurassic sediments. This uplift has resulted from Kimmerian tectonic activities connected with an extensive volcanism along NW—SE trending fracture zones

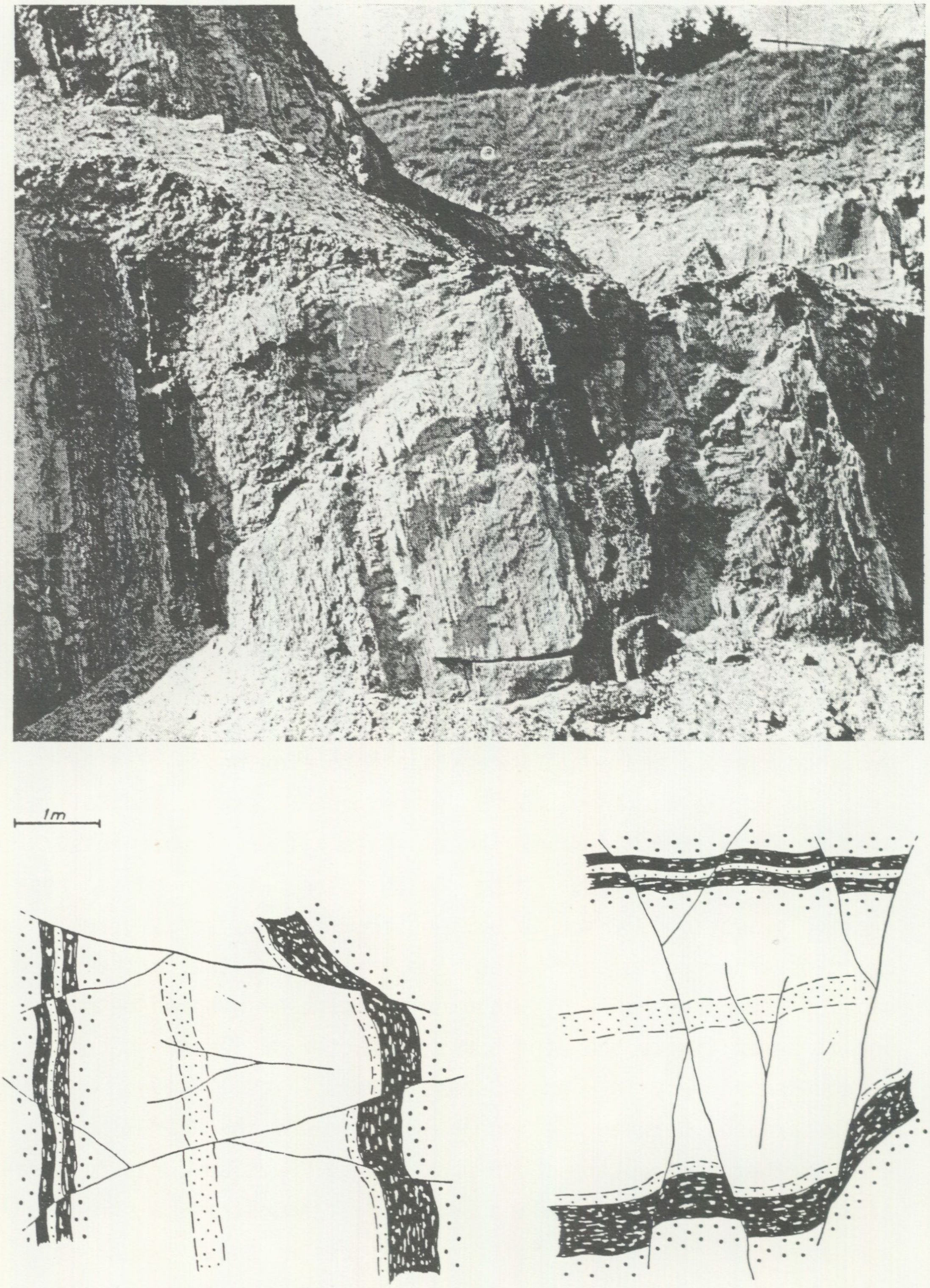


Fig. 20. Two generations of Kimmerian structures in the Fyleverken sand pit at Eriksdal. Viewed towards the northwest. Left drawing shows interpretation, right drawing illustrates pre-tilt condition. (Modified from Bölau 1973.)

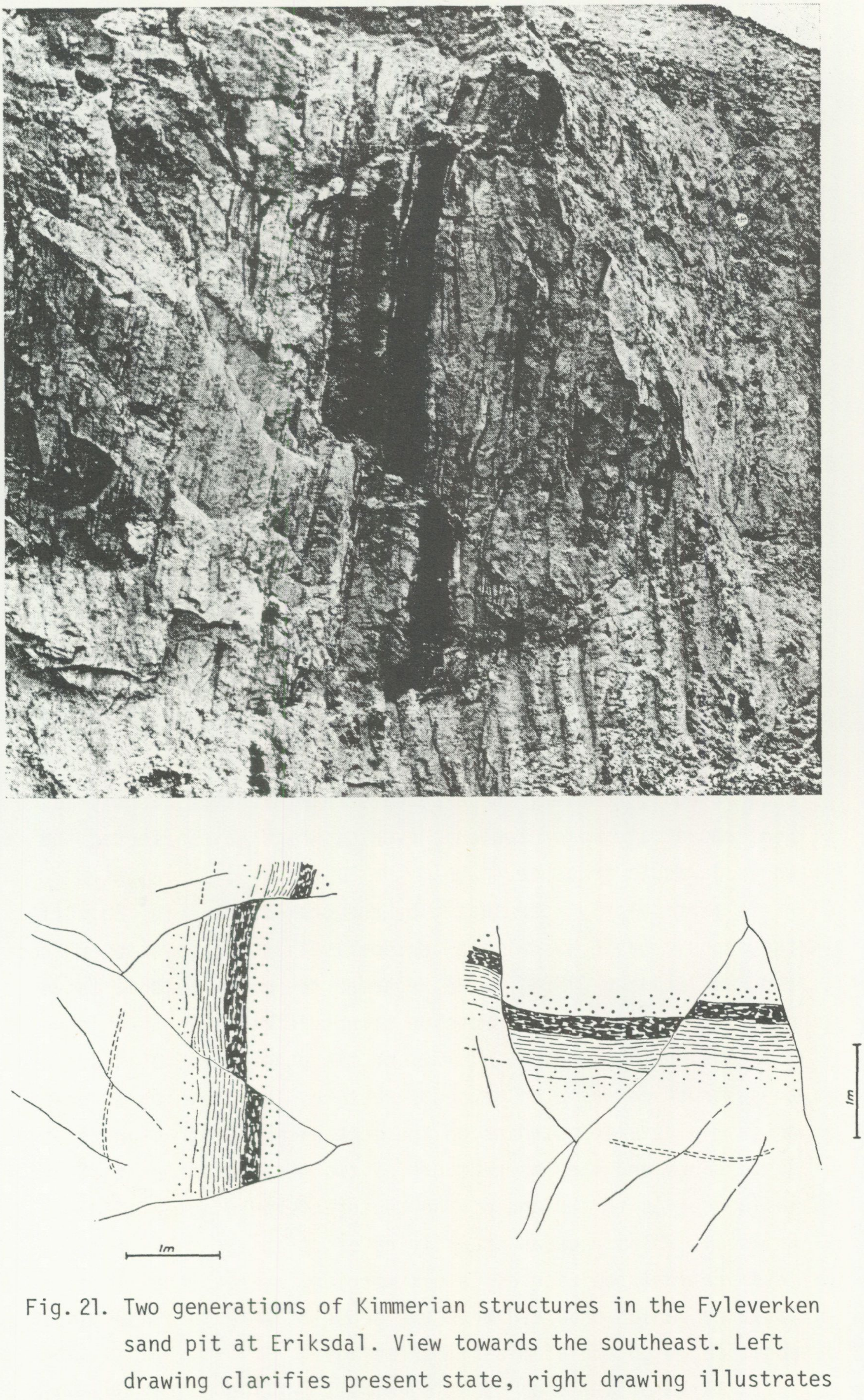


Fig. 21. Two generations of Kimmerian structures in the Fyleverken sand pit at Eriksdal. View towards the southeast. Left drawing clarifies present state, right drawing illustrates pre-tilt condition. (Modified from Bölau 1973.)

(Fig. 16). In fact, more than 70 localities with basalts and tuffites are known from Central Scania (J. Bergström 1981a). Radiometric datings (Klingspor 1973) indicate Middle Jurassic to Early Cretaceous and early Late Cretaceous ages (Mid-Kimmerian-Late Kimmerian and Subhercynian volcanism). Palynological datings of a basalt tuff from Central Scania have yielded an age around the Early/Middle Jurassic transition (Tralau 1973).

Late Kimmerian tectonics (Late Jurassic-Early Cretaceous)

The tectonic activity was particularly extensive at the end of the Jurassic, but activities in the earliest Cretaceous may also be included in the late Kimmerian tectonic phase.

The only locality in Scania where sedimentary strata affected by late Kimmerian movements can be studied in the field is the sand pit of the Fyleverken Company at Eriksdal (Excursion stop 8).

Before the mining of sand and clay at Eriksdal started, the local Middle and Upper Jurassic geology, including its stratigraphical representation and tectonic development, was very little known. Today, however, the exposed strata are sufficiently dated and demonstrate major tectonic events, which have affected the whole Jurassic sequence.

As particularly accentuated by the coal-seams (Fig. 20, 21), the deposits at Eriksdal are vertically tilted or even overthrusted. Christensen (1968, p. 8) regarded the major Fyledal tectonic disturbance as a compression structure resulting from tangential tension. Bölau (1959, 1973), on the other hand, stated that this structure was a collapsed structure. This opinion is based on fairly detailed studies on the mechanism and structure of the disturbance and the observations of two generations of tectonic influence. As to the age of the tectonic events observable at Eriksdal, Bölau regards the tilting of strata to their more or less vertical position as late Kimmerian, whereas the slight faulting, which occurred when the deposits were in a horisontal position, might be of mid-Kimmerian age.

In Kullemölla-1, a c. 650 m deep well drilled by the Geological Survey of Sweden (SGU) in 1919 some 5 km SE of Eriksdal, a more or less horisontal sequence of Upper Cretaceous depsits, standing on steeply dipping Jurassic-lower Cretaceous strata, was penetrated. The tectonic event causing this unconformity might be the same as the one affecting the Eriksdal Mesozoic sequence. Guy Ohlson (1982 in press) has recently dated the unconformity by palynological methods. Her results indicate an earliest Cretaceous rather than a late Jurassic age.

In western Scania the boundary between the Fennoscandian Border Zone and the Danish-Polish Trough, e.g. in the Helsingborg-Landskrona area, is represented by faulted flexures essentially resulting from Triassic, Jurassic, and Early Cretaceous tectonic activities (Figs. 14, 16). The structural geology of this area is dicussed at some length in the description for Rönneberga backar (Excursion stop 4).

Cretaceous tectonics - JB

In the southwest Scanian part of the Danish-Polish Trough the Early Cretaceous brought a temporary end to the tectonic instability characterizing much of the Jurassic. The Lower Cretaceous and Cenomanian form a fairly thin but continuous cover over the Jurassic substratum (Fig. 23).

With the Late Cretaceous a new tectonic pattern was introduced. As a whole the area southwest of the Romeleåsen fault and flexure zone acted as a single block that underwent successive subsidence. The cumulative subsidence exceeded 1000 m. The general subsidence was greatest in Santonian, Campanian and Maastrichtian times, with corresponding thicknesses of over 350, 225 and 547 m, respectively, at Höllviken. In the Campanian there was a pronounced tilting towards the Romelåsen zone, resulting in the deposition of up to 300—400 m of partly sandy sediments. As a consequence, the Upper Cretaceous measures 1700—1800 m in thickness close to Romeleåsen. The most pronounced movements appear to have occurred in the Early Campanian, which may also be the interval of greatest tectonic disturbance in the Kristianstad area (cf. Fig. 24). The most important faulting inside the block seems to have occurred along the (Trelleborg-)Svedala Fault, but the movements were small as compared to older ones along the same lineament.

The Vomb Basin showed a complicated tectonic pattern during the Cretaceous, but the details are insufficiently known. The Lower Cretaceous to Cenomanian sequence is comparatively thin except in the Köpingsberg area, which is just south of an E—W trending horst traversing the Vomb Basin (Fig. 22). Older Mesozoic sediments appear to have been partly removed from the E—W horst and were perhaps redeposited just to the south in connection with active faulting. In the Late Cretaceous the Vomb Basin was successively tilted towards the northeast, while it was also dissected by numerous faults with various directions. The important northeast boundary, the Fyledalen Line, is a combined flexure and fault zone. Vertically tilted beds along the Fyledalen Line include Upper Campanian strata (Moberg 1910; Gravesen 1977), which indicates active movements until late in the Cretaceous. The thickest sequence, however, is found in the Santonian (200——400 m), which may have been the epoch with greatest vertical movements.

The Kristianstad area is a landward extension of the Hanö Bay (cf. Fig. 10). A general characteristic is the southward tilting of the basement surface against boundary faults: Nävlingeåsen, Linderödsåsen, The Christiansö Horst (Kornfält et al. 1978, Fig. 31; Kumpas 1980, Fig. 18, 64; Lidmar-Bergström 1982, Fig. 41). Initiation of movements in these boundary faults is indicated by the oldest sediments, which are found closest to the faults. In the Hanö Bay there appears to have been vertical movements along the Christiansö Horst roughly from the Triassic-Jurassic transition and more or less continuously throughout much of the Jurassic and Cretaceous, in up to around 1000 m of sedimentary rocks. As in the Vomb Basin, subsidence (and faulting?) was particularly noticeable in the Santonian (Norling & Skoglund 1977). The deeper sediments bordering Linderödsåsen have not been completely penetrated by any boring, and dating of the movements is therefore premature. Drillings along the Nävlingeåsen Ridge have fairly recently revealed a trench with at least 175 m of sedimentary rocks on the northern side. The fault amount is estimated at some 130 m south of Kristianstad. In this area the sedimentary sequence

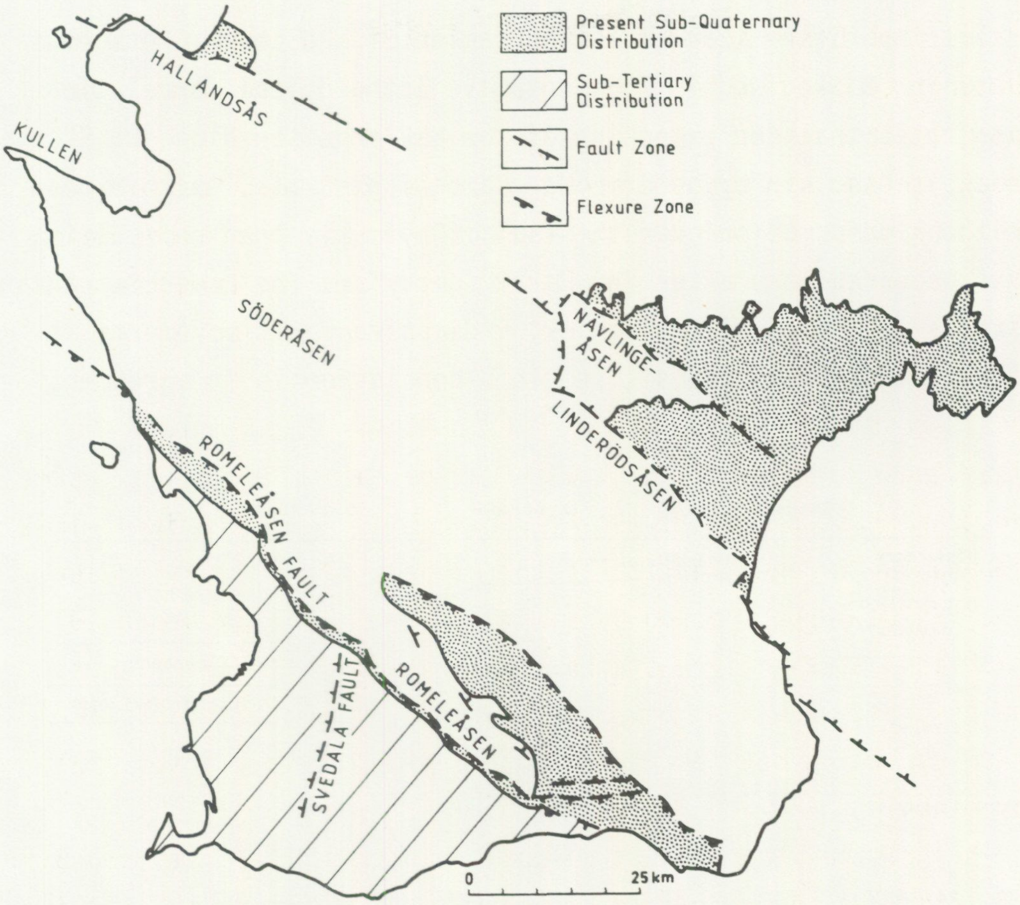


Fig. 22. Map of Scania showing distribution of Cretaceous rocks and main Cretaceous tectonic lineaments.

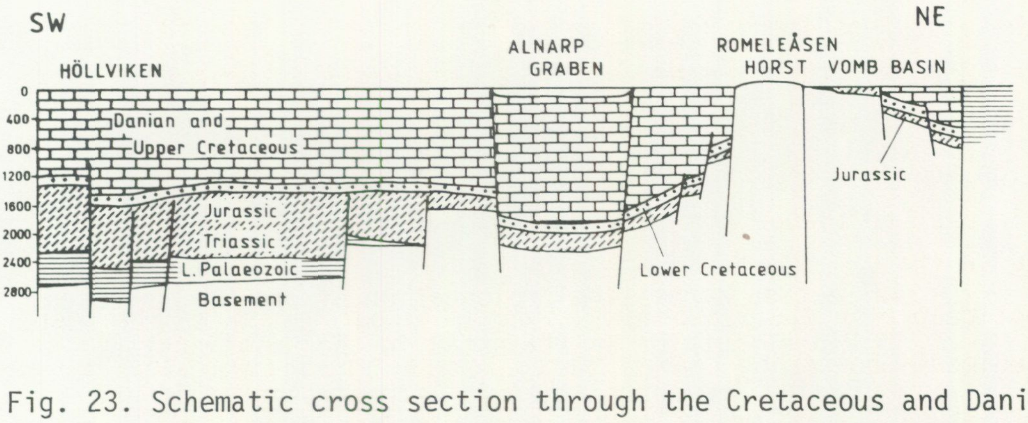


Fig. 23. Schematic cross section through the Cretaceous and Danian from the southwestern corner of Scania through the Danish-Polish Trough, the Romeleåsen Horst, and the Vomb Basin in the northeast. The tectonic pattern is simplified.

starts no higher than in the Barremian of the Lower Cretaceous (Norling & Skoglund 1977). Tentative lithological correlation indicates that the extension of the Nävlingeåsen Ridge at Skönabäck is overlain by upper Lower Campanian strata, which extend without deformation over the fault. Obviously then no faulting has occurred here after the Early Campanian. The Lower Campanian strata are comparatively thick, indicating fault movements at the time of their deposition. This conclusion is in agreement

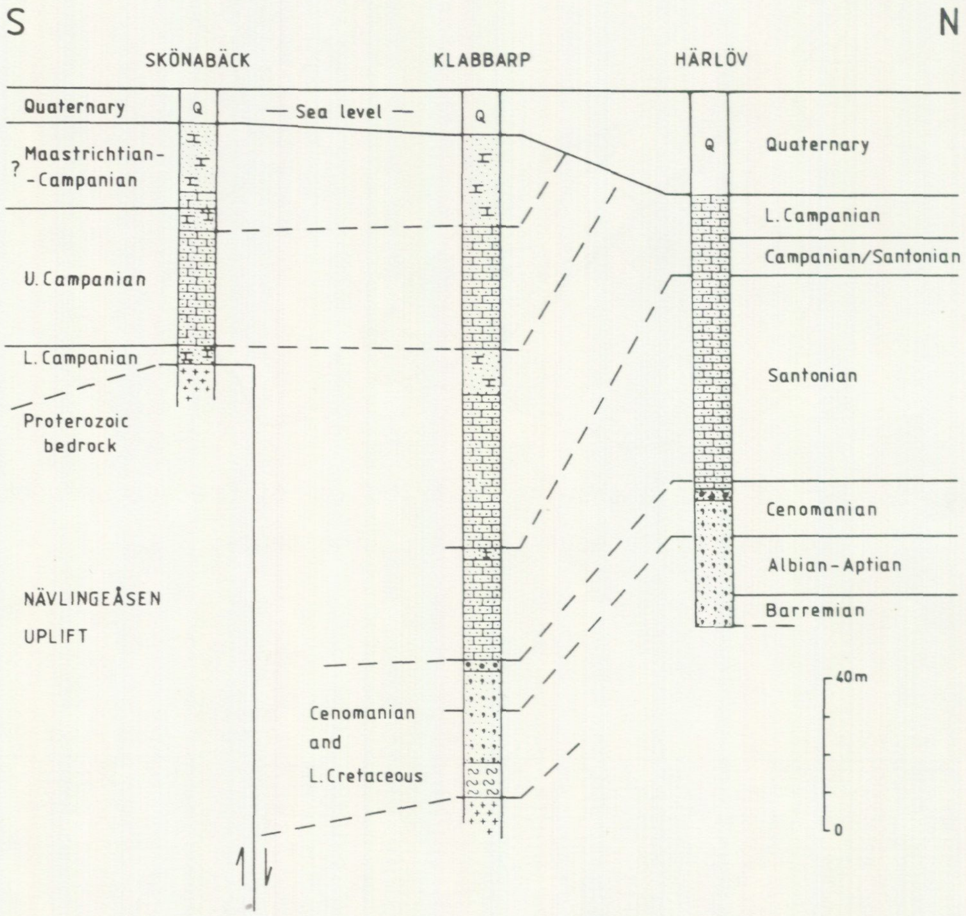


Fig. 24. Section across the prolongation of the Nävlingeåsen Ridge south of Kristianstad in the Kristianstad Basin. The correlation is lithostratigraphic and only tentative. Dating is based on the established biostratigraphy of the Åhus and Härlöv borings (cf. Kornfält et al. 1978). The diagram indicates that fault movements were definitely finished in or immediately prior to the Early Campanian.

with the fact that at Ringeleslätt along the Nävlingeåsen Ridge the Santonian strata tilt up to 45^0 out from the fault (Grönwall 1915; cf. Kornfält et al. 1978, p. 87, Fig. 33). Presumably faulting along the Nävlingeåsen Ridge started some time in the Early Cretaceous, then culminated and ended in the Early Campanian.

The Båstad Basin was tilted southwards towards the Hallandsåsen Horst (Fig. 22) and filled with sediments in the interval

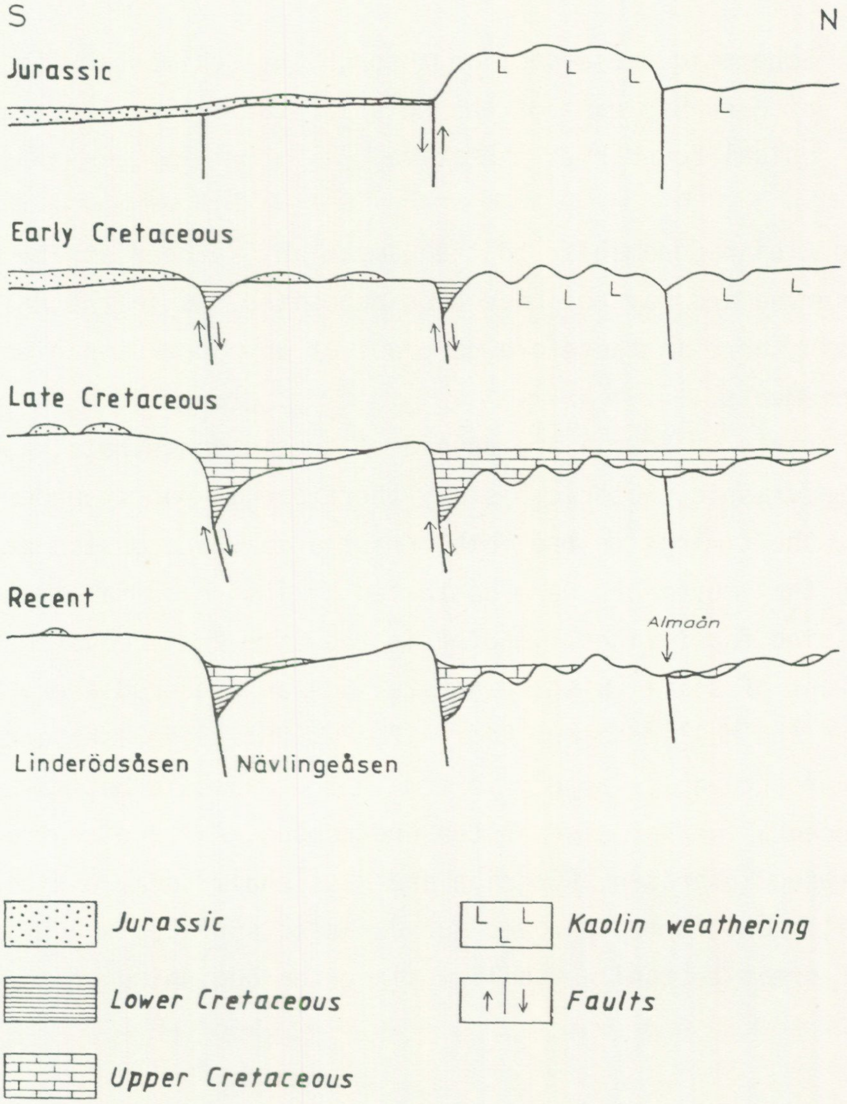


Fig. 25. Schematic illustration of the development of the Kristianstad Basin during the Mesozoic, with inversion movements, kaolin weathering, sedimentation and denudation. From Kornfält et al. 1978.

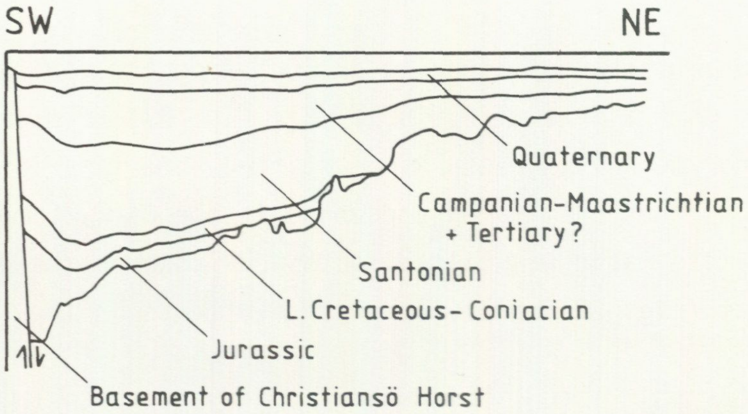


Fig. 26. Schematic cross section through the sedimentary sequence of Hanö Bay east of the Kristianstad Basin. Stratigraphical boundaries tentative.

from the Albian-Cenomanian to the Campanian. Younger strata are not preserved and may not have been deposited. As in the Kristianstad Basin there is therefore no proof of any post-Campanian tectonic movements.

Large parts of Scania are devoid of Cretaceous strata, and the post-Jurassic tectonic history therefore is poorly understood. However, the timings in the Vomb, Kristianstad and Båstad Basins indicate that movements were dominated by inversion faulting in pre-existing fault-lines, leading in the Late Cretaceous to the development of still existing horsts such as Linderödsåsen, Nävlingeåsen and Hallandsåsen (Figs. 22, 24, 25). Söderåsen and Kullen were probably largely formed in the Jurassic but may have experienced a further rise in the Cretaceous. A large central area between Söderåsen, Ringsjön and Hässleholm today exhibits a virtually undeformed exhumed sub-Jurassic surface, which is proof of great tectonic stability since the beginning of the Jurassic.

Cenozoic tectonics - JB

Tertiary rocks in Sweden are virtually confined to the Paleocene and Eocene of the Danish-Polish Trough, although erratics of similar and younger ages have been found also in northern and eastern Scania. The preserved strata are dominated by the Danian (Lower

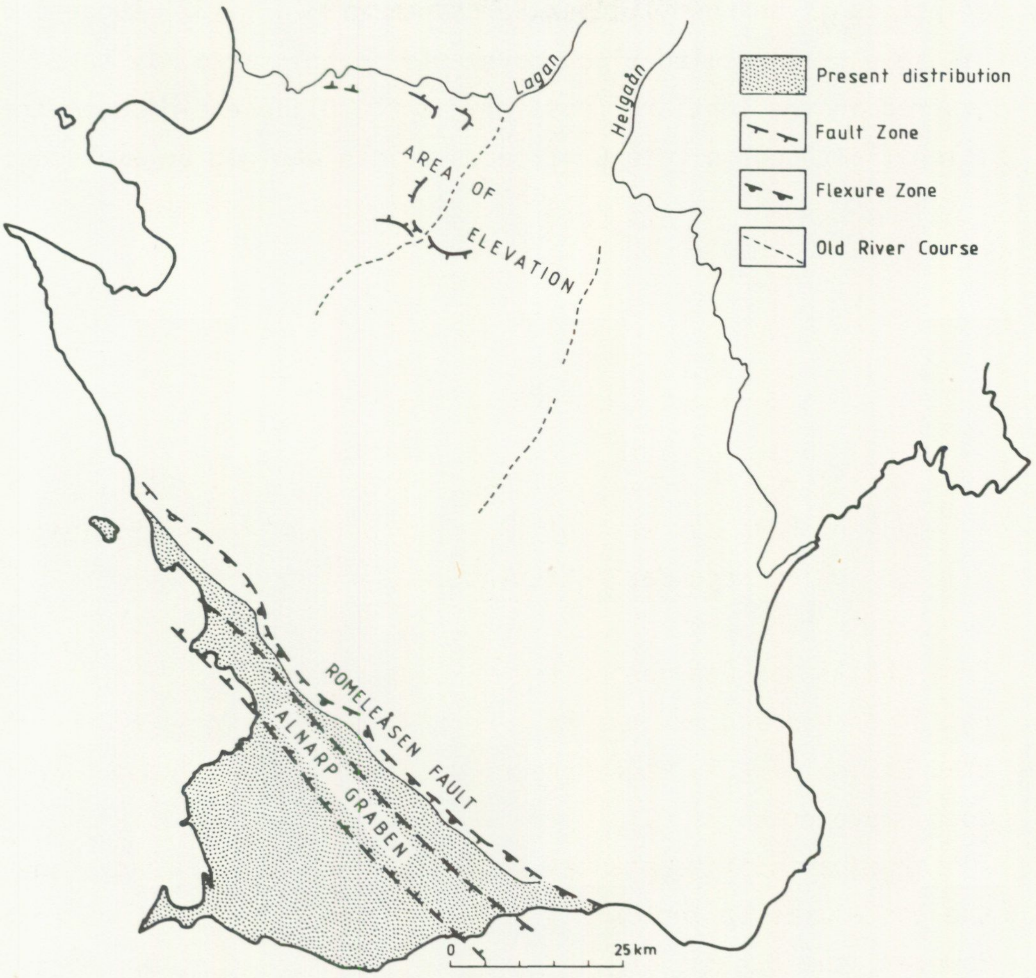


Fig. 27. Cenozoic of Scania. Distribution of sedimentary rocks, main tectonic features, and deflected river courses. Partly compiled from Troedsson (1932) and Lidmar-Bergström (1982, Fig. 8).

Paleocene). The marine sedimentation apparently was accompanied by a subsidence of the trough through moderate vertical movements along the Romeleåsen Fault. Southwest of this fault and parallel with it lies the Alnarp Valley, which seems to be a graben structure (Fig. 27). The absence of upper Tertiary strata in the valley may indicate a Quaternary age of the present depression.

The central parts of northern Scania have experienced a comparatively late rise. This is indicated by the distribution of Cretaceous ourliers and flint erratics (Lidmar-Bergström 1982, p. 32) and by the deviation from apparent original courses of rivers such as Lagan and Helgeån (Troedsson 1928, 1932). The age of the deflection is unknown. Lidmar-Bergström (1982, p. 32) suggested that some small-scaled block movements in this area may have occurred in the Tertiary (possibly at the Oligocene-Miocene transition), although a Late Cretaceous origin can not be excluded.

STOP 1. LIMHAMN QUARRY

Brian Holland

Object: Danian limestones with bioherms and the Maastrichtian/ Danian boundary.

The occurrence and stratigraphy of the Maastrichtian and Danian in Sweden are chiefly known through the publications by Brotzen (1940. 1944. 1948. 1959). The systematics and stratigraphic distribution of planktic Foraminifera from the Maastrichtian and Danian strata of southern Sweden have been studied by Troelsen (1957), Berggren (1960, 1962a, b) and Malmgren (1974, 1976). Berggren erected a 3-fold zonation of the Danian: the Danian Stage is equated with the *Globoconusa daubjergensis* Zone Pl, while the three subzones are, from the base of the Danian, *Subbotina pseudobulloides* Subzone Pla, *S. triloculinoides* Plb and *Planorotalites compressa* Plc (Fig. 9).

Malmgren (1974) found it possible to recognize a further subdivision of the Plc Subzone, applicable to the Danian of southern Scandinavia. This zonule is characterized by (1) the presence of *P. compressa* and (2) statistically significant right coiling of *S. pseudobulloides*. Berggren´s and Malmgren´s zonations are summarized and correlated with the Limhamn section in Fig. 28.

Kjellström & Hansen (1981) described the distribution and occurrence of dinoflagellates from the Upper Maastrichtian and Danian of the Limhamn area.

Limhamn Quarry is the principle exposure of the Danian Stage in the type area in southern Scandinavia. It is also the easternmost exposure of the Maastrichtian-Danian boundary in the Danish-Polish Trough. At the present, almost 60 m of uppermost Maastrichtian chalks and Danian limestones are exposed in the quarry. Brotzen (1959) described in detail the section at Limhamn and recognized the Maastrichtian-Danian boundary. The sequence of Danian limestones in the Quarry was divided by him into four zones based on the spines of the regular echinoid *Tylocidaris*. Recent work on the dinoflagellate distribution in the Danian of Denmark

(Hansen 1977) has demonstrated the *Tylocidaris* zonation to be diachronous relative to the dinoflagellate zonation. Therefore the *Tylocidaris* Zones, corresponding to the lower, middle and upper Danian, should be regarded as lithostratigraphic (or biosomal) units.

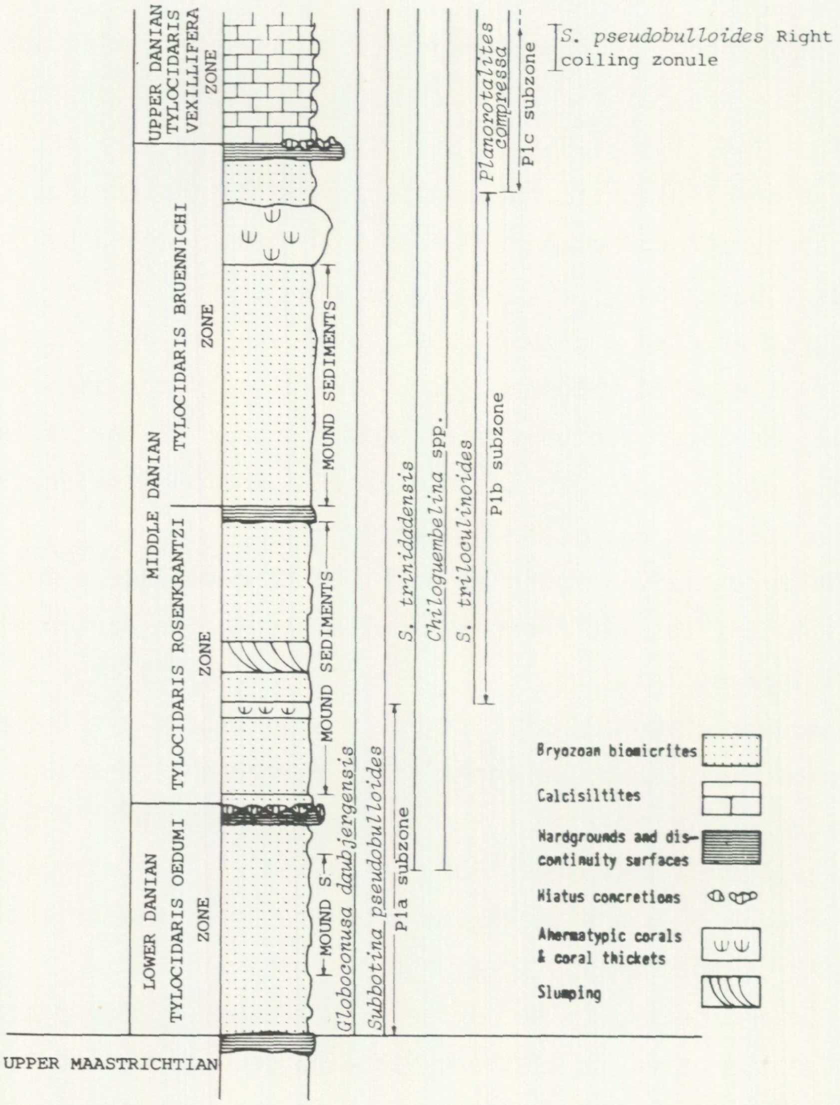


Fig. 28. Schematic and composite section of the Maastrichtian and Danian sequence at Limhamn. The *Tylocidaris* zones, the standard planktic foraminiferal zones (Pla-c) and the occurrence and range of the planktic Foraminifera of the Danian sequence are shown.

The uppermost Maastrichtian

Approximately 3 m of uppermost Maastrichtian chalk are exposed in a section at the lowest level in the quarry. The Maastrichtian is composed of rather hard white chalk intercalated with two marly layers and five levels of flint-filled burrows (*Thalassinoides*). The top of the Maastrichtian sequence is a hardground. No encrusting or boring organisms are present on the hardground. Brecciation, reworking of fragments of the hardground into burrows present in the hardground and hiatus sediments in the burrows indicate synsedimentary lithification of this bed before the deposi-

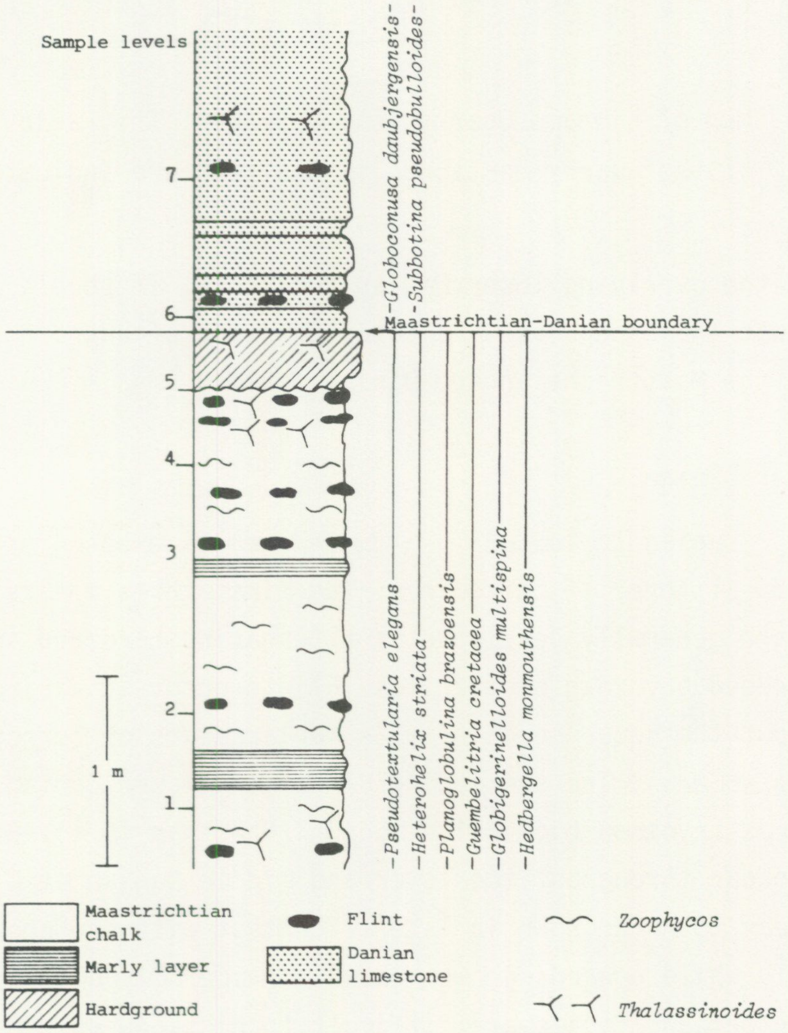


Fig. 29. Detailed section of the Maastrichtian-Danian boundary at Limhamn, south Sweden, indicating the occurrence of planktic Foraminifera.

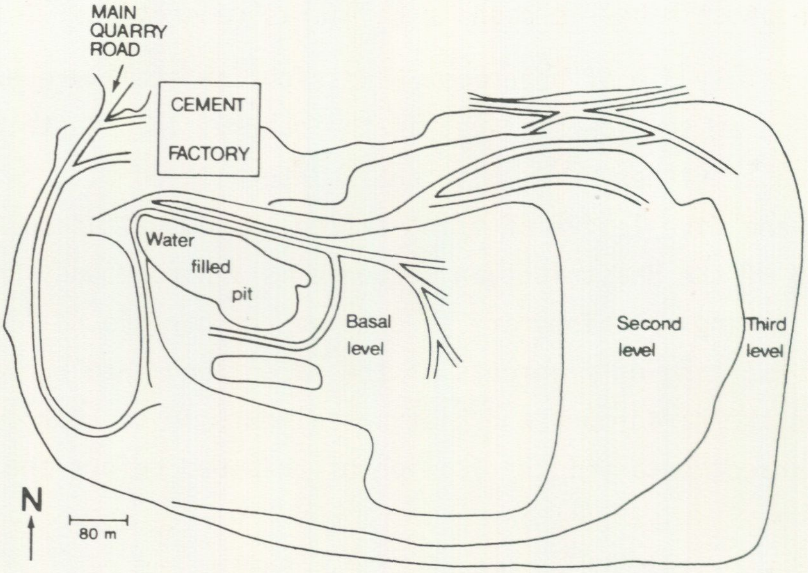


Fig. 30. Map of Limhamn Quarry, south Sweden. The various levels of the quarry mentioned in the text are indicated.

tion of the overlying lower Danian sediments. It should also be noted that the hardground indicates a hiatus of unknown duration between the Maastrichtian and Danian.

The lower Danian

The lower Danian (*Tylocidaris oedumi* Zone) is exposed around the entire basal level of the quarry. The first three meters of the Danian are generally developed as alternating hard and soft, level-bedded bryozoan biomicrites. Flints occur at various levels throughout the sequence chiefly as replacements of burrow fill (*Thalassinoides*). The succeeding 8 m of the lower Danian are developed as bryozoan biomicrite mounds (Cheetham 1971). Bryozoan mounds occur throughout the lower and middle Danian at Limhamn and appear to have grown in lateral contact with one another generally while upwards growth shows considerable overlapping. Thus, intermound facies are difficult to distinguish. The uppermost 4 m of the lower Danian are, incontrast to the mounds, essentially level-bedded bryozoan biomicrites. The top of this zone is a 1 m thick massive limestone bed which can be followed around nearly the entire basal floor of the quarry. The upper surface of this bed is paved with hiatus concretions. These synsedimentarily lithified concretions indicate a period of nondeposition and a certain degree of submarine erosion. The concretions are slightly phosphatized and the hard substrate colonized chiefly by boring sponges and terebratulid brachiopods.

The middle Danian

The middle Danian is comprised of a lower and upper bryozoan biomicrite mound complex. These are referred to the *Tylocidaris rosenkrantzi* Zone and the *T. bruennichi* Zone respectively. The middle Danian sequence begins with 0.5–1 m alternating hard and soft, level-bedded bryozoan biomicrite beds. Upwards, these beds are replaced by the lower bryozoan mound complex which is approximately 12 m thick. Throughout the quarry the upper parts of the mounds in this complex frequently show evidence of slumping, with up to 6–10 m lateral and downward displacement of mound sediments. Both simple displacement and mushrom-like anticlinal folds, accentuated by late flint diagenesis within burrows, can be seen in the north wall of the basal level of the quarry.

Approximately 20 m above the base of the middle Danian a minor discontinuity has been observed and can be regarded as marking the boundary between the two mound complexes of the middle Danian. The upper complex of the middle Danian mounds is exposed around the next level of the quarry.

A definite change in the depositional environment is indicated in the uppermost middle Danian, exposed in the third level of the quarry. Here, an extensive level of ahermatypic coral bioherms or thickets is developed on the crests and flanks of the large upper middle Danian bryozoan mounds. These lenticular shaped bioherms are 3–15 m long and 2–4 m high. The bioherms or thickets are highly fossiliferous and support a very diverse invertebrate fauna. The sporadic occurrence of the light dependant coral *Heliopora incrustans* indicates growth of these bioherms at least within the lower limits of the photic zone. The bryozoan mounds are believed to have been deposited in somewhat deeper water, around 100–200 m (Cheetham 1971). The ahermatypic coral bioherms are covered by 1–4 m level-bedded biomicrites. The uppermost bed of the middle

Danian is a discontinuity surface which shows great lateral variation and development. Along the northern half of the quarry the discontinuity surface is represented by a complex well-developed hardground and hiatus concretions. Southwards in the quarry the hardground is replaced by an unlithified discontinuity surface.

The upper Danian

The upper Danian, *Tylocidaris vexillifera* Zone, is best exposed along the south wall of the upper level of the quarry. Here, 8–10 m of alternating hard and soft calcisiltites and calcarenites occur above the discontinuity surface that tops the middle Danian. Grey to black *Thalassinoides* flints are prominent throughout the sequence. In contrast to the rest of the Danian sequence the upper Danian sediments lack mounds and bioherms and are generally characterised by very low faunal diversity. The uppermost beds of the Danian have been glacially eroded and the sequence is covered by Quaternary deposits.

STOP 2. HARDEBERGA

Jan Bergström

Object: Lower Cambrian strata and Permo-Carboniferous dolerite.

Hardeberga is situated a few kilometres east of Lund, in a position where the Proterozoic basement of the Romeleåsen Horst dips towards the northwest beneath Lower Palaeozoic rocks. Hardeberga Quarry exploits the upper part of the Lower Cambrian sandstone and Permo-Carboniferous dolerite dikes, the latter cutting the sedimentary sequence. The quarry is operated by AB Sydsten.

The lowest formation in the sequence is the Hardeberga Sandstone. The thickness is unknown, but a drilling made by AB Sydsten in the northernmost part of the quarry penetrated 94 m of Hardeberga Sandstone without reaching the underlying basement. The drilling started just under the top of the formation, apparently only some 2 m from the top according to information from Mr. Bror Arvidsson, former engineer at AB Sydsten. The entire

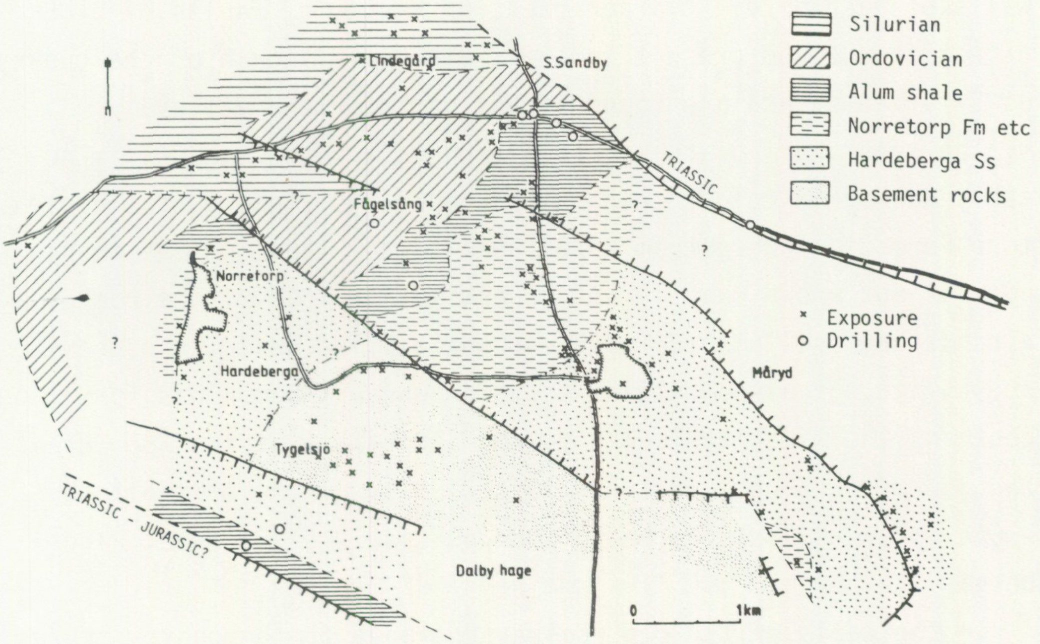


Fig. 31. Geological sketch map of the northwest end of the Romeleåsen Horst east of Lund. The Hardeberga Quarry is indicated at Hardeberga.

thickness is probably between 100 and 150 m.

The Hardeberga Sandstone is a pure whitish quartz arenite (up to 98% silica) with fairly little variation throughout the drill core (Bror Arvidsson, pers.comm.). The sand is obviously the result of the winnowing of weathered basement rocks and deposition in a shallow near-shore environment (cf. Hadding 1929). Ripple marks, mud cracks and clay galls are occasionally found. Locally there is impregnation or fissure fillings of fluorite, and there are rare veins of galena. This mineralization was presumably caused by the Permo-Carboniferous magmatic event.

The fauna is poor, consisting of trace fossils such as *Diplocraterion parallellum, Skolithos linearis, "Scolithus" errans, Syringomorpha nilssoni,* and the trilobite type trace fossil *Rusophycus parallellum* (Hadding 1929; Bergström 1970). Shale Partings in the quarry have yielded acritarchs (Vidal 1981). The association indicates a medial Early Cambrian (post-Tommotian) age.

The sequence in and outside the quarry is penetrated by Permo-Carboniferous dolerite dikes trending roughly NW—SE (Troedsson 1917; Hjelmqvist 1940; Regnéll 1960, Fig. 8). As seen in the sections there is only minor vertical displacement between the two walls of each dike. A larger fault or system of faults of W—E direction must be present in the small valley north of the quarry, as Silurian strata are found in and north of the valley.

The upper half of the northwestern wall in the quarry is notably darker in colour than the surroundings. This is the Norretorp Formation (Bergström 1970). Due to the faulting the thickness is not known exactly but is estimated at 15 m. The rock is a sandstone (siltstone?) with carbonate, glauconite, phosphorite and pyrite. It also contains titanium and uranium. This formation contains the first trilobite fauna, indicative of the *Schmidtiellus mickwitzi* Zone (Bergström 1973, 1981). Of the trilobites, *Wanneria? lundgreni* has been found outside the quarry at Hardeberga.

In the walls of the old railway entrance to the quarry there is an exposure of the two uppermost formations of the Lower Cambrian (Troedsson 1917; Hadding 1929, p. 83; 1958, pp. 61—64 Hansen 1937, pp. 157—159, 179; Bergström & Ahlberg 1981). The

Rispebjerg Sandstone varies much in composition but tends to be a matrix-supported sandstone, the grains of sand consisting of fairly large well rounded quartz particles. The matrix is phosphatic, and if conclusions based on this formation in Bornholm are applied (de Marino 1980b), the calcium phosphate should have been formed by diagenetic transformation of calcium carbonate. The rock contains occasional pyrite lumps. Fossil fragments can be seen in the matrix but no determinable specimens have been found.

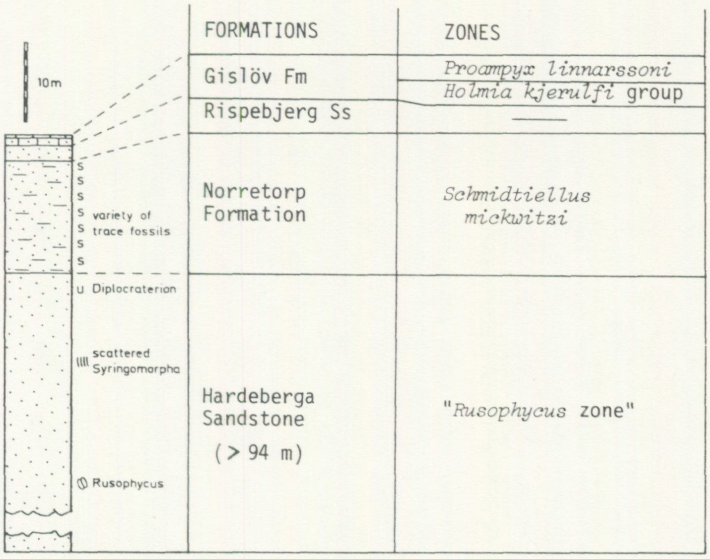


Fig. 32. Lower Cambrian sequence of the Hardeberga area. Vertical scale only approximate.

The Rispebjerg Sandstone is overlain by the Gislöv Formation, which is a condensed suite yielding at least two trilobite zones despite its inconsiderable thickness, only about 0.8 m at Hardeberga (Fig. 33). The contact with the overlying Middle Cambrian Alum Shale was visible until some 10 years ago but is now destroyed. The formation contains some calcium carbonate throughout. The lowest part has picked up grains of sand from the underlying Rispebjerg Sandstone. Higher in the section there is a variable influx of sand, silt, glauconite and phosphorite. The fauna of the *Holmia kjerulfi*-group Zone contains i.a. trilobites (including a possible *Calodiscus lobatus*) and brachiopods. A few brachiopods may represent the overlying *Proampyx linnarssoni* zone. The fauna has recently been re-described (Ahlberg & Bergström 1978; Bergström & Ahlberg 1981).

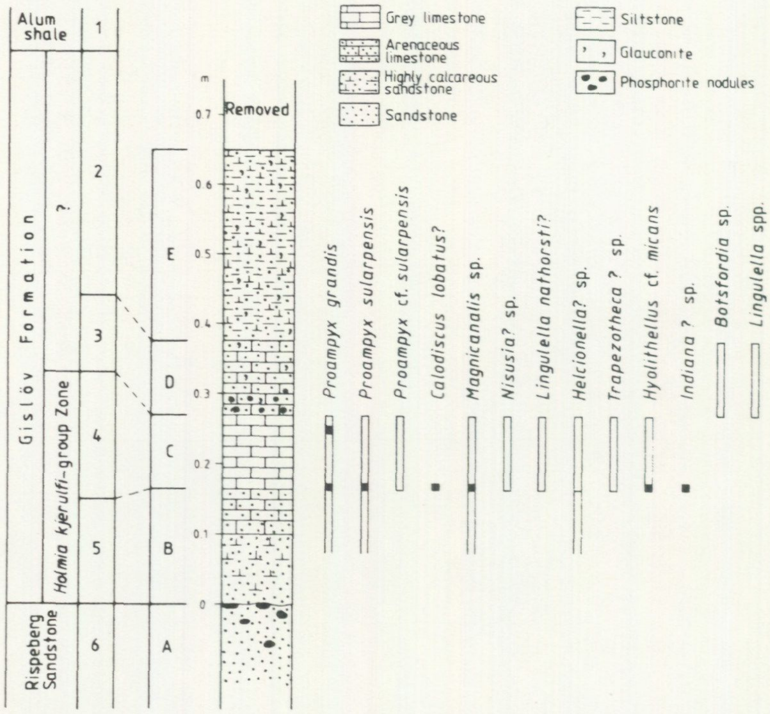


Fig. 33. Stratigraphic column at Hardeberga quarry east of Lund, showing lithologies and distribution of fossils in the uppermost Lower Cambrian. Open bar indicates allocation of museum specimens after lithological characteristics, filled bar represents detailed sampling. Figures 1—6 indicate divisions of Troedsson (1917, section II). The difference in measurements are due to swift lateral changes in thickness. Middle Cambrian alum shale no longer exposed. From Bergström & Ahlberg 1981.

STOP 3. Ö. ODARSLÖV

Jan Bergström

Object: Graptolite shale and mudstone around the Middle/Upper Silurian boundary.

The quarry at Ö. Odarslöv is situated north of Hardeberga where the dipping northwestern end of the Romeleåsen Horst is covered by Silurian strata. The quarry was opened about a decade ago by Cementa Company (Euroc AB) in order to provide clay minerals for the large cement production at Limhamn. The shale was used as a substitute for bentonite previously imported from Greece. This import became politically unattractive when Greece was taken over by a military government.

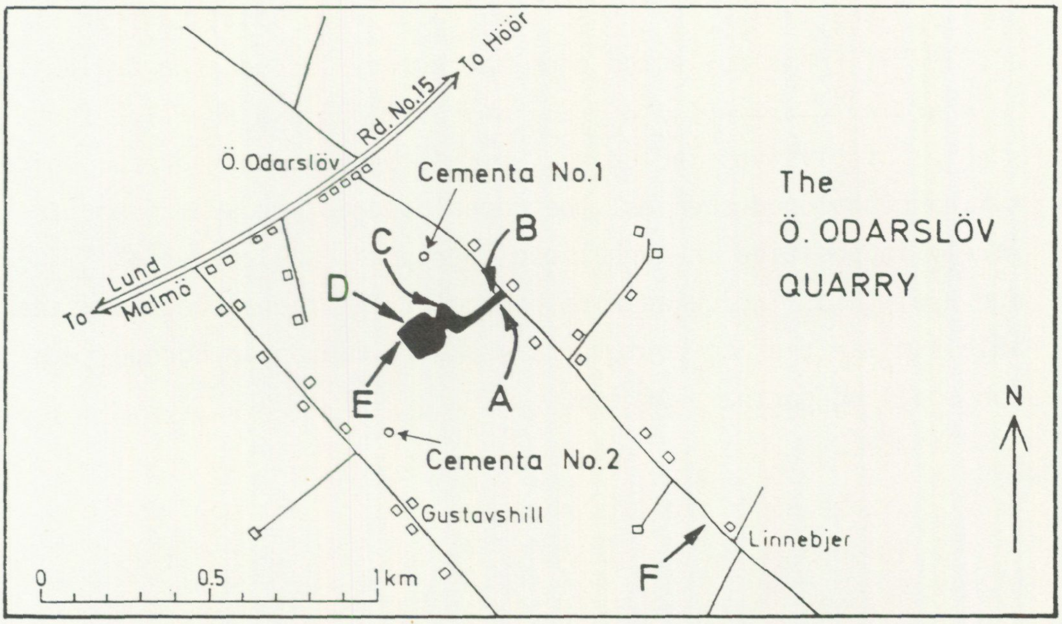


Fig. 34. Shale quarry at Östra Odarslöv. Letters indicate fossil localities. From Laufeld et al. 1975.

The section exposed in this quarry belongs to the Upper Wenlock (Middle Silurian; Fig. 5). A thin sequence belonging to the *Cyrtograptus lundgreni* Zone. It is overlain by some 6 m of shale belonging to the *Gothograptus nassa/Pristiograptus dubius* interregnum (or *G. nassa* Zone; Nyers & Nilsson 1973; Laufeld et al. 1975). This sequence belongs to the Cyrtograptus shale, which in the quarry is characterized by a conspicuous lamination due to rhythmic deposition. Grey and dark grey laminae alternate throughout the exposed sequence. The shale is rich in organic content. Apart from microfossils, fossils found in the quarry include the graptolites *Cyrtograptus lundgreni, C. hamatus, Monograptus testis* (lower zone), *Gothograptus nassa,* and *Pristiograptus dubius* (upper zone).

The Cyrtograptus Shale is overlain by more massive olive grey mudstone, of which up to 1.5 m has been exposed (at A, B and E in Fig. 34); still preserved at E; see Laufeld et al. 1975). This mudstone forms the base of the Colonus Shale and seems to indicate a shallowing of the sea. The fauna includes the graptolite *Pristiograptus jaegeri,* which together with acritarchs indicates the base of the *Pristiograptus ludensis* Zone. There is also a shelly fauna typical of this level (e.g. Hede 1915; Laufeld et al. 1975). Forms collected from the quarry include the trilobites *Dalmanitina (Struveria) simrica* and *Raphiophorus roualti,* four species of bivalves including *Cardiola interrupta,* several unidentified cephalopod species, the cephalopod aptychus *Aptychopsis* sp, rarely in position in cephalopod apertures (Holland et al 1978), and hyolithids including rare opercula. The fauna shows considerable similarities to contemporary shelly faunas in Europe (e.g. Bohemia) and northern Africa.

STOP 4. RÖNNEBERGA BACKAR

Erik Norling

Object: View over part of northwest Scania

This locality, about 100 m a.s.l., is situated on the boundary between the Danish-Polish Trough and the Fennoscandian Border Zone (Figs 1, 10).

Though covered by Quaternary deposits, the flat lowland to the south and west reflects the smooth morphology of the Upper Cretaceous-Danian rock surface.

The NW—SE trending zone of rough topography on which we are standing, includes narrow stripes of Lower Jurassic, Middle Jurassic, Upper Jurassic and Lower Cretaceous strata having a flat-Hercynian strike. Further towards the NW, beneath the Sound between Scania and Sealand, their strike changes towards a more steep-Hercynian direction.

In the Landskrona-Helsingborg area, this boundary between a regional area of uplift (Fennoscandian Shield) in the northeast and a regional area of major subsidence (Danish-Polish Trough) in the south-west, is characterized by 4—5 km broad flexures. They affect Triassic, Jurassic, Lower and Mid-Cretaceous strata, in the south-west succeeded by more or less horisontal layers of Maastrichtian-Danian chalk.

At various depths the flexures are penetrated by Kimmerian, Austrian(?), and Sub-Hercynian faults, reflecting tectonic activities which are also indicated by unconformities and stratigraphical gaps observed in cores from bore-holes in the area.

The landscape to the north of Rönneberga backar mainly includes Upper Triassic arkoses and clays beneath the Quaternary cover. To the east Lower Palaeozoic shales occur, penetrated by swarms of NW—SE trending Carboniferous-Permian dolerite dikes.

The seismic section between Vallåkra and Landskrona (Figs 35 and 37) illustrates the flexure character of the boundary between the Danish-Polish Trough and the Fennoscandian Border Zone.

In other areas, however, this boundary might be represented by a zone of very steep faults.

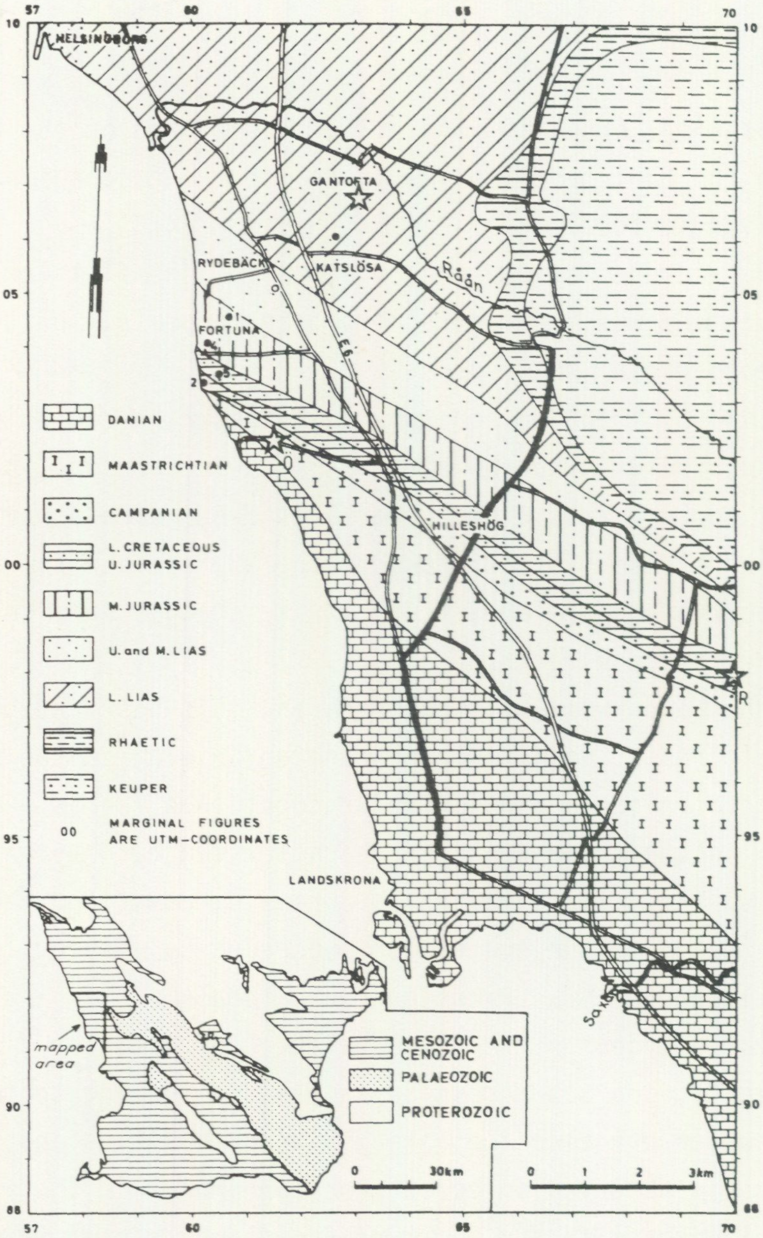


Fig. 35. Geological sketch map of the Landskrona-Helsingborg area. Stars mark location of Örenäs Slott (Ö), Gantofta Brick Pit (Stop 6) and Rönneberga Backar (R; Stop 4). Heavy black line marks the location of seismic section in Fig. 37.

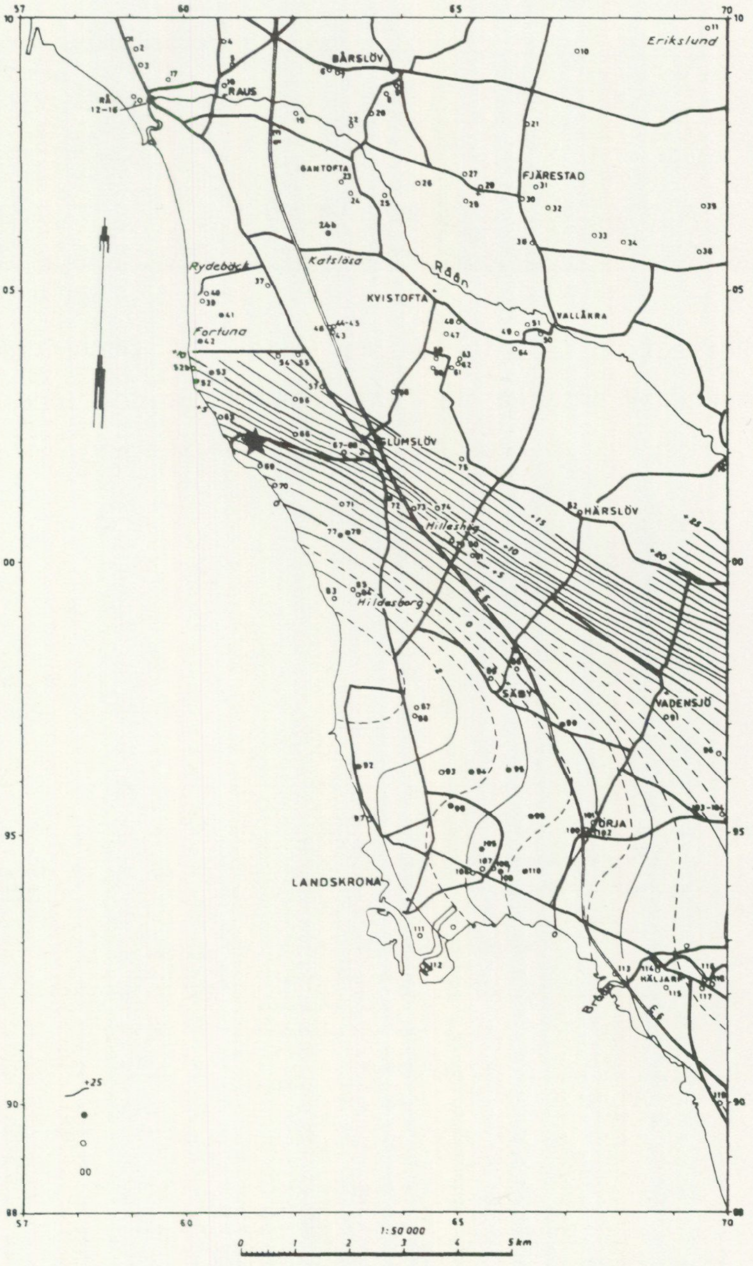


Fig. 36. Bouger anomaly map of the Landskrona-Helsingborg area.
Black star marks the location of Örenäs Slott.

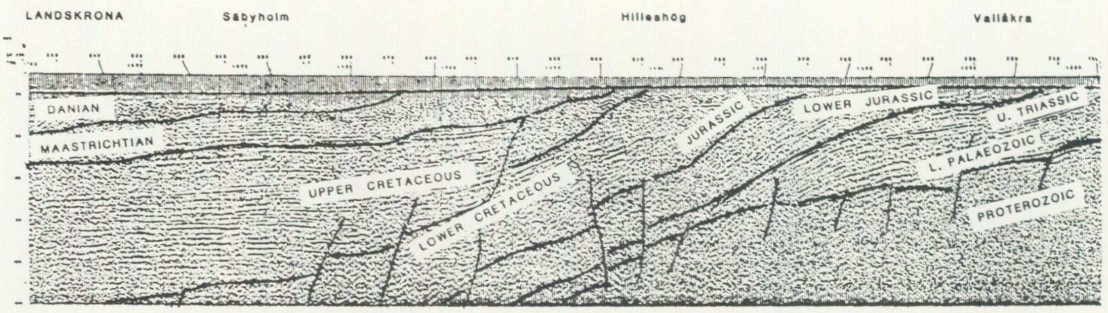


Fig. 37. Reflection seismic section (NNE—SSW) traversing the boundary between the Fennoscandian Border Zone and the Danish-Polish Trough. For location see Fig. 35.

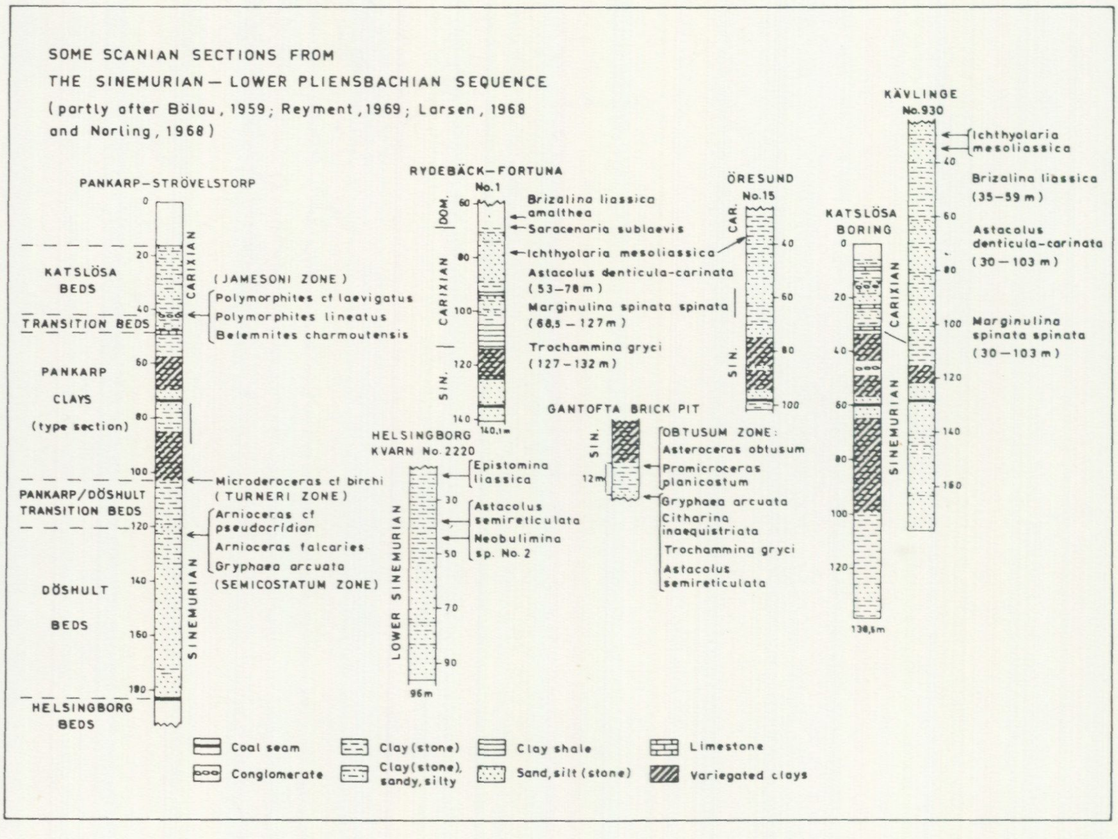


Fig. 38. Some sections from the Sinemurian-Pliensbachian sequence in Scania.

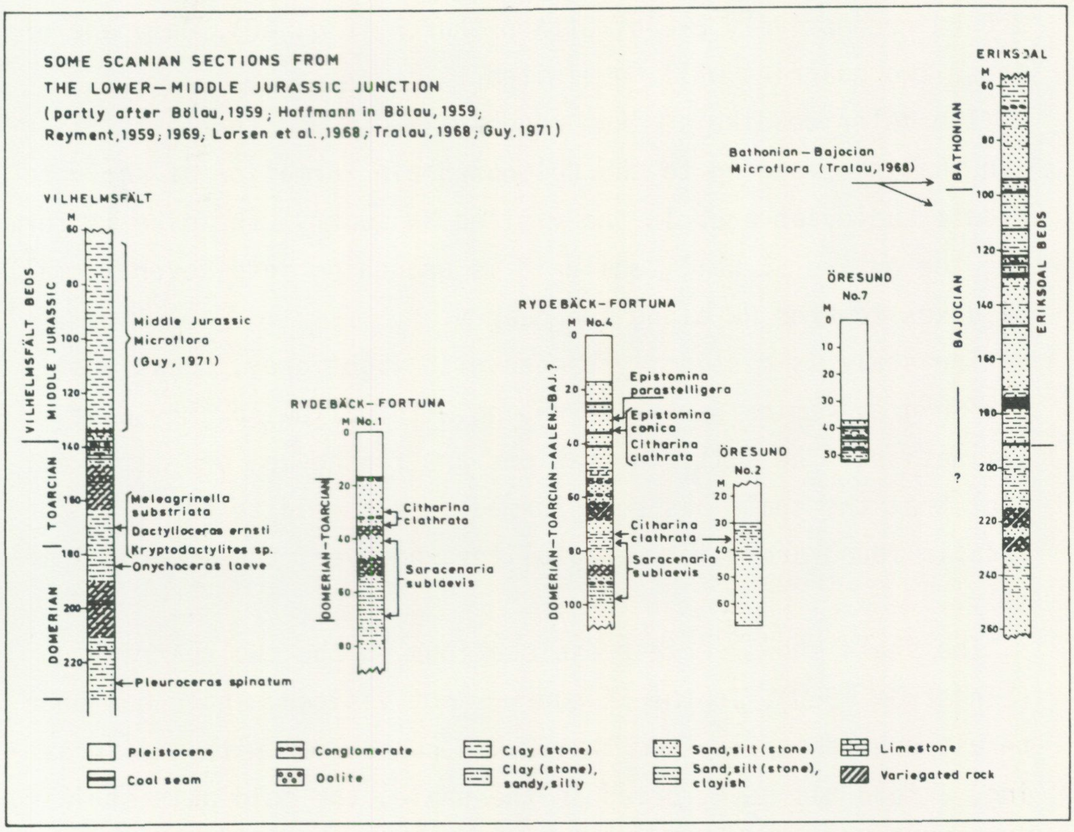


Fig. 39. Some sections from the Lower-Middle Jurassic transition in Scania.

STOP 5. RÖNNARP

Kent Larsson

Object: NW—SE dolerite dike intruding Upper Silurian shales.

A 65 m wide dolerite dike is exposed in two quarries 2.2 km and 2.6 km respectively ENE of Ottarp Church (Fig. 40). Only one of these two quarries will be visited.

The dolerite dike strikes roughly NW—SE and transects Silurian shales belonging to the Colonus Shale Formation of Early to Middle Ludlovian age. In the visited NW quarry, the dike is forming the entire SE wall, while it is branching into several smaller dikes towards NW along the quarry.

The shale is distinctly banded with light grey, occasionally bluish grey laminations alternating with yellowish grey silty laminations. The silty laminations are fining-up, and it is evident that the shale has been formed as a turbidite deposit. The fossils found are mainly graptolites, however, these occur sparsely.

The shale shows certain dislocations in the two quarries (Lindström 1960). In the SE quarry (not visited) shale has been thrust over dolerite from the SW. In connection with the thrusting, a fold has been formed in the shale, the fold axis striking about N 60° W. The amplitude of the fold is only some 10 cm. Farther westwards along the same wall in the SW part of the quarry, the shale has been thrown into a fold plunging 23° in N 20° E and with a wave-length of about one metre. The fold is cut discordantly by a wrench-fault striking N 23° W.

The folds in the NW quarry occur in the NE wall of the quarry. They strike mainly about N 45° W—S 45°E, although other strikes occur as well. They vary slightly in style and wave-length, and are in part overturned towards NE and have wave-lengths of less than one metre. They are best developed near the NE contact zone between the dolerite and the shale.

The main components of the dolerite dike are plagioclase, pyroxene and ore, which together make up about 80% of the rock. The plagioclase is often sericitized and saussuritized and is a labradorite—andesine. Micrographic intergrowths of plagioclase and quartz are common. Quartz, biotite and apatite are prominent, as are secondary minerals such as chlorite, hornblende, serpentine and calcite, which contribute between 10 and 20% of the total rock. Epidote, zircon, talc, potassium feldspar and albite appear in small amounts. Veins of calcite are common.

The dolerite dike at Rönnarp has been subjected to paleomagnetic (Mulder 1971, Bylund 1974) as well as radiometric (Klingspor 1976) dating. Mulder (1971) investigated a total of 16 samples from the dolerite dike and obtained average values of declination and inclination of 190^{o} and -11^{o} respectively for the magnetic direction of the dike. A pole position of 37^{o} N 174^{o} E was obtained. Bylund (1974) obtained similar values, i.e. a declination of 202.5^{o} and an inclination of -13^{o}. The pole position obtained was 38.5^{o} N 168.5^{o}E. Both paleomagnetic investigations indicate a Late Carboniferous intrusion age of the dike.

Table 1. K-Ar data for dolerites in the NW—SE dike system.

Sample and locality	Type of rock	Mineral concentrate and grain size	K, %	$^{40}Ar_{rad}$ mol/g $\cdot 10^{-10}$	$^{40}Ar_{rad}$/ $^{40}Ar_{total}$ %	Age, Ma
71137 Rönnarp	Dolerite		0.69 ±0.01	3.40 ±0.05	78	259 ± 4
71138 Rönnarp	Dolerite		0.44 ±0.01	2.43 ±0.03	85	287 ± 4
71139 Rönnarp	Dolerite		0.36 ±0.01	2.05 ±0.03	86	298 ± 4
71139 Rönnarp	Dolerite	Plagioclase, 71–100 μ	0.32 ±0.004	1.55 ±0.02	87	254 ± 4
71139 Rönnarp	Dolerite	Pyroxene, 71–100 μ	0.11 ±0.001	0.47 ±0.001	49	232 ± 3
71140 Rönnarp	Dolerite		0.28 ±0.004	1.55 ±0.02	80	287 ± 4
71141 Rönnarp	Dolerite		0.19 ±0.002	0.98 ±0.01	87	271 ± 4

Table 2. K-Ar data for Silurian shale intersected by NW-striking dolerites.

Sample and locality	Distance from the dolerite m	K, %	$^{40}Ar_{rad}$ mol/g$\cdot 10^{-9}$	$^{40}Ar_{rad}$/ $^{40}Ar_{total}$ %	Age, Ma
72024 Rönnarp	0.5	3.20 ±0.04	1.58 ±0.02	92	259 ± 4
72027 Rönnarp	9	3.68 ±0.05	1.97 ±0.03	94	280 ± 4
73018 Rönnarp	400	2.65 ±0.03	2.48 ±0.04	91	463 ± 7
73020 Rönnarp	550	2.50 ±0.03	2.07 ±0.03	92	416 ± 6
73022 Rönnarp	1300	2.37 ±0.03	2.11 ±0.03	97	444 ± 6

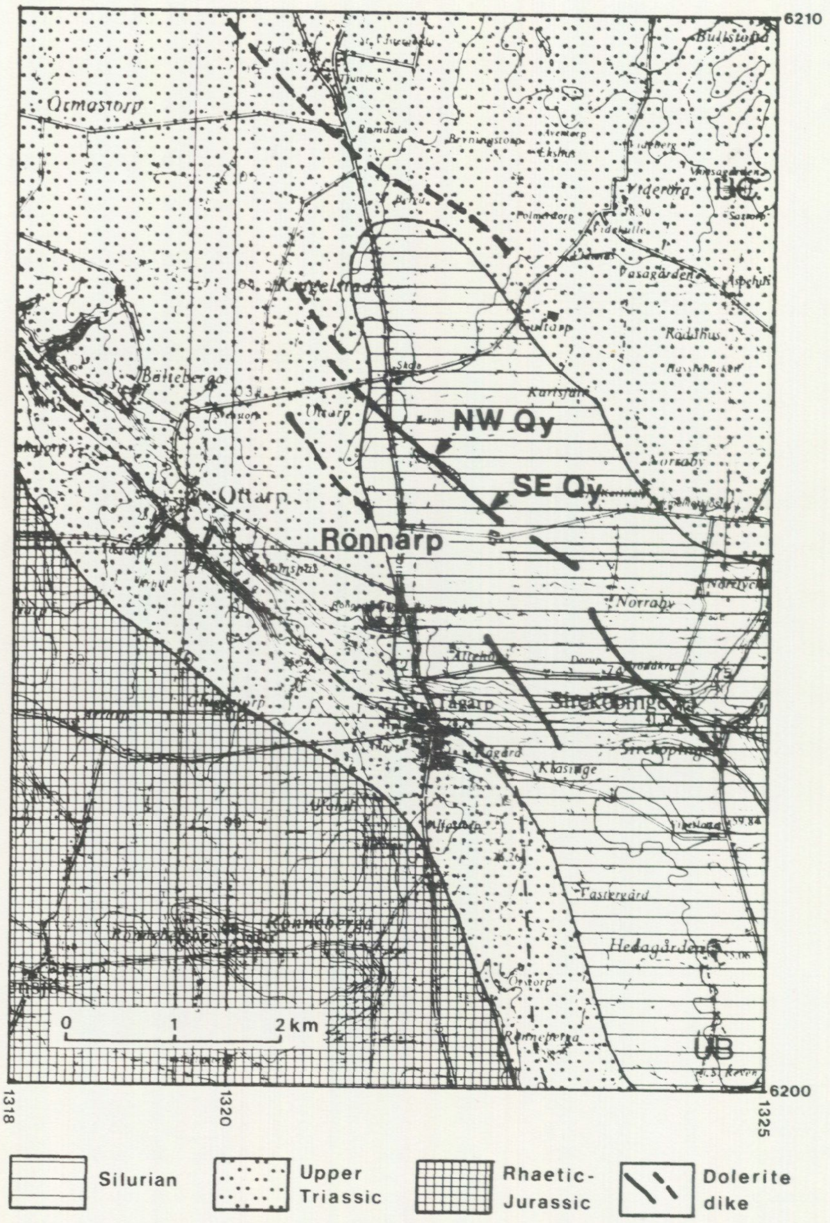


Fig. 40. Map of the Rönnarp area with locations of the northwest and southeast dolerite quarries (NW Qy, SE Qy).

Klingspor (1976) carried out radiometric age determinations of 7 samples from the dolerite dike. Besides five shale samples were dated radiometrically. K - Ar data from these investigations are summarized in Tables 1 and 2. The dolerite samples gave ages between 232 and 298 Ma. These values should be compared to the isochron age of 294 Ma of the dolerite intrusion in Palaeozoic rocks in Scania derived from a total of 21 samples

(Klingspor 1976, Fig. 7). This isochron age would mean an intrusion age of the dolerite dikes in Late Carboniferous. The wall rock of the dolerite dike was also dated radiometrically, mainly in order to study the thermal effects on the retention of argon in the shales during intrusion of the dolerite dikes. Totally five samples at various distances from the dike were dated (Table 2). Two samples 0.5 and 9 m from the dike gave apparent ages of 259 and 280 Ma respectively, which corresponds approximately to the dike's calculated age of 294 Ma. At a distance of 400 m, the apparent age was 463 Ma. An X-ray diffraction study of the shales shows no differentiation in composition between samples taken at various distances from the dolerite dike (Klingspor 1976, p. 208).

STOP 6. THE GANTOFTA BRICK PIT

Ulf Sivhed

Object: Lower Jurassic (Sinemurian), the Döshult and Pankarp Members.

The Pit belongs to the Höganäs Company. Sediments of the Pankarp Member are quarried and used for the manufacture of fire-bricks. The section has been described by Reyment (1969a, pp. 208—216; 1969b, pp. 440—442), Norling (1972, pp. 22—23), Lund (1977, p. 32, Text-Fig. 5) and Sivhed (1977, pp. 1—31; 1980, pp. 35—36, Text-Fig. 19; 1981, pp. 249—252; Text-Figs 1—2).

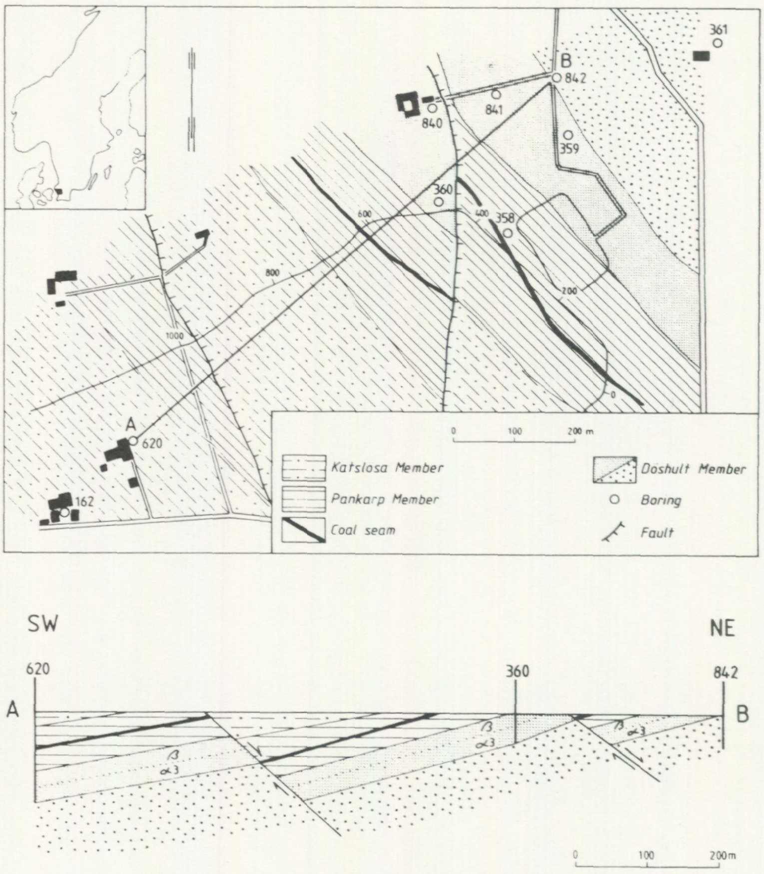


Fig. 41. Jurassic geology of the Gantofta-Katslösa area. The two symbols for the Döshult Member stand for argillaceous and arenaceous parts.

Döshult Member

Lithology: The sediments of the Döshult Member are made up of marine, dark grey, slightly silty claystone with a few ferruginous beds.

Biostratigraphy: Norling (1972, pp. 22—23) described a foraminiferal fauna from a bed rich in the oyster *Gryphaea arcuata* appearing in the basal part of the sequence. He referred the fauna to the Lower Sinemurian.

Reyment (1969a, pp. 208—216; 1969b, pp. 440—442) described an ammonite fauna obtained from the upper part of the Döshult Member, near the boundary of the Pankarp Member. The ammonite fauna contains i.a. *Asteroceras obtusum*, the zonal denominator of the *A. obtusum* Zone, indicating the Upper Sinemurian. About 2 m above the ammonite yielding horizon, the Döshult member is followed by the Pankarp Member.

Lund (1977, Text-Fig. 5) described palynomorphs from two samples representing the Lower and the Upper Sinemurian respectively.

Sivhed (1977; 1981, pp. 35—36, Text-Fig. 19) described the ostracode fauna. The fauna consists of i.a. *Ogmoconchella danica*, *Cristacythere betzi* and *C. crassireticulata*, the zonal denominators of the *O. danica* Zone and the *C. betzi* - *C. crassireticulata* Zone respectively.

Pankarp Member

Lithology: The sediments of the Pankarp Member consist of marine variegated (red, green, grey and yellow) clays.

Biostratigraphy: The fossil material obtained from the Pankarp Member is restricted to palynomorphs.

Geology

In the Gantofta-Katslösa area (Fig. 41), the Liassic sediments strike mainly N 45° E and have a main dip between 15° and 25° to the southwest. Two strike-slip faults have been observed in the area (Fig. 41; Bölau 1973; Sivhed 1981, pp. 250—252), one in the western part and one in the eastern part. The fault in the western part of the area has a strike of about N 65° W. The eastern fault has a north-south strike. The eastern fault has a throw of 35 m and a heave of 50 m. The western fault has a calculated throw of 55 m and a calculated heave of 65 m.

STOP 7. BJÄRSJÖLAGÅRD

Kent Larsson

Object: Upper Silurian shales and limestones.

The quarry forms the type locality for the lowermost unit of the Öved-Ramsåsa Beds, i.e. the Silurian strata which form the youngest Palaeozoic beds in Scania (and Sweden). The quarry is now filled with water and only the uppermost part of unit 1 is accessible. However, outcrops in some drainage canals and ditches in the surroundings, together with two boreholes drilled by the Geological Survey (SGU) in 1967, make a stratigraphical assessment possible of the three lower units of the Öved-Ramsåsa Beds. The locality has been treated in various contexts in a number of publications during the last century. For a full list of references see Larsson 1979, p. 180. The quarry was formerly operated for lime-production, but has been abandoned for almost five decades. The quarry has been cut about 8 metres below the present water surface.

The lowermost beds consist of grey to reddish grey coarse-grained limestone and grey to bluish-grey dense limestone. The former variety is mainly composed of corals and crinoidal fragments, the latter of calcareous algae. This algal limestone is upwards gradually passing into a brownish grey, arenaceous shale alternating with thin beds of impure limestone. Samples from the described sequence can today be studied in the heaps of debris deposited east of the quarry. The limestone sequence is distinguished into a subunit, 1b. In borehole no. 1 (Fig. 42), drilled in the easternmost part of the quarry, the thickness of this subunit, the Bjärsjölagård Limestone, is about 25 m.

The beds exposed in the quarry today consist of greyish blue to yellowish grey micaceous shales, in the lower part alternating with grey limestone beds. The entire sequence dips 8—10° towards SE and has been penetrated by some minor faults. In the westernmost part of the quarry some minor discordant beds can also be seen.

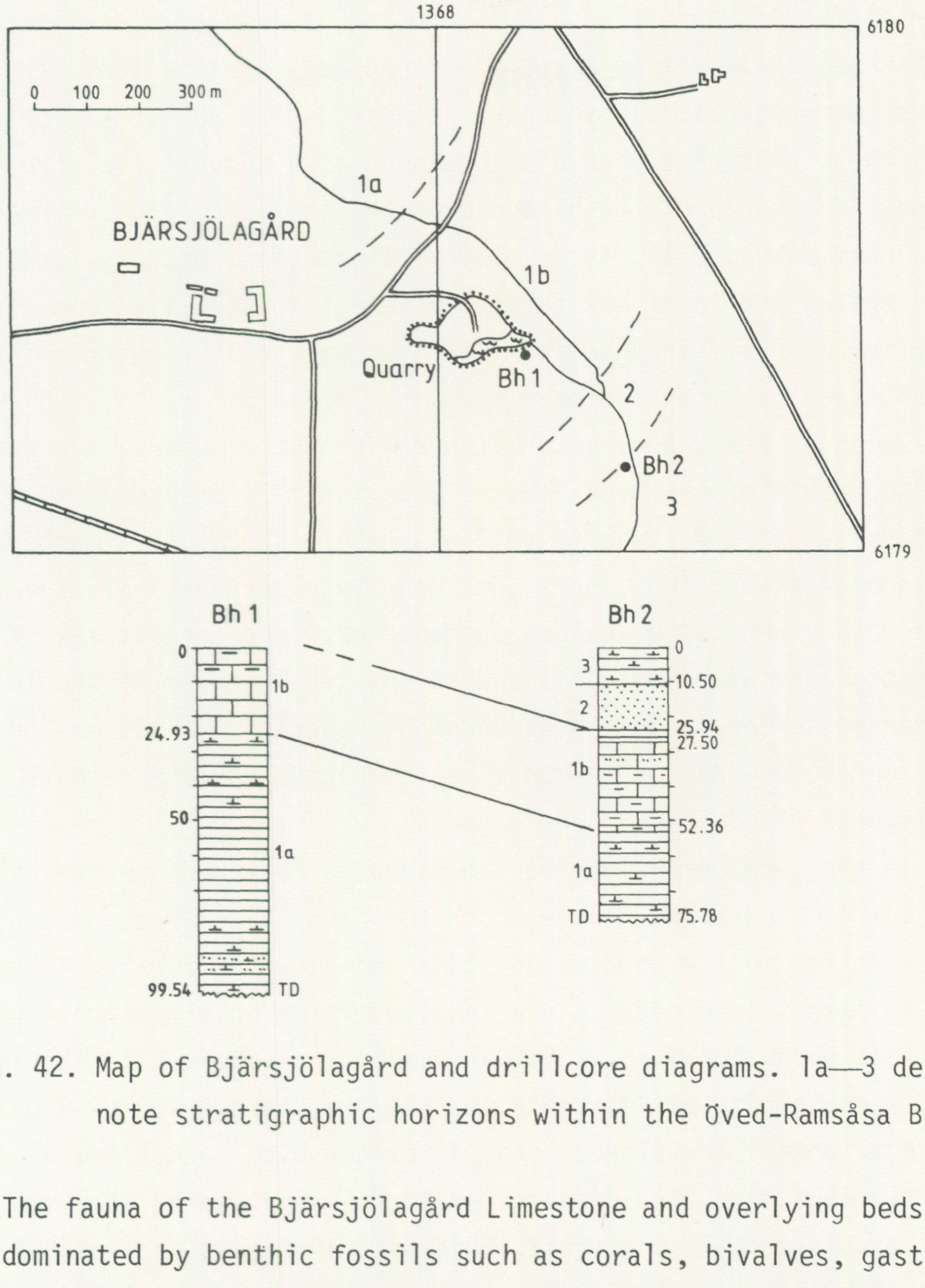


Fig. 42. Map of Bjärsjölagård and drillcore diagrams. 1a—3 denote stratigraphic horizons within the Öved-Ramsåsa Beds.

The fauna of the Bjärsjölagård Limestone and overlying beds is dominated by benthic fossils such as corals, bivalves, gastropods, brachiopods, ostracodes, trilobites, tentaculitids and algae. The limestone has formed a large biohermal lens which laterally passed into thin limestone beds alternating with arenaceous shales.

On faunistical evidence, unit 1 of the Öved-Ramsåsa Beds can be referred to topmost Ludlovian, i.e. the Ludfordian Stage.

North and south of the quarry older and younger units of the Öved-Ramsåsa Beds, respectively, can be studied in part. The oldest beds of unit 1 can be seen in a drainage canal about 500 m north of the quarry. These beds consist of a grey, occasionally micaceous shale with intercalated thin beds of limestone. These beds get progressively younger southwards. On faunistical criteria these beds have been distinguished as a subunit, 1a. From about 80 m north of the bridge crossing the canal and southwards, the next subunit, 1b, is developed. It consists of grey limestones and shales and forms a lateral equivalent to the limestone lens earlier quarried in the Bjärsjölagård Quarry. The sequence is dislocated by minor faults.

South of the quarry in a ditch draining the quarry, the next younger unit of the Öved-Ramsåsa Beds, unit 2, occurs in small outcrops. It consists of a yellowish white sandstone almost devoid of fossils. Thus, only some poorly preserved bivalves and some plant remains have been encountered. Therefore its exact stratigraphical position is uncertain, i.e. whether it should be referred to the Ludlovian or Downtonian Series. In one of the SGU boreholes, no. 2, the unit has been penetrated and shows a thickness of 13.5 m.

In the same borehole, the sandstone is followed upwards by 10.5 m of bluish grey shale which for faunistical reasons can be referred to the Downtonian. This shale, which further to the south passes into reddish grey shales, forms unit 3 or the Öved-Ramsåsa Beds. Today it is not accessible in outcrops in the immediate vicinity of Bjärsjölagård. Further to the south, a still younger unit is developed, unit 4, or the Öved Sandstone, a red partly micaceous fine-grained sandstone, which forms the youngest Palaeozoic deposit in Scania. This unit signifies the arrival of the Old Red sedimentation in southernmost Scandinavia. Unit 4 is also of Downtonian age.

As a whole, the Öved-Ramsåsa Beds, as seen in the vicinity of Bjärsjölagård and in two other areas in Scania, show a typical shallow-water character, both lithologically and faunistically. The beds contrast markedly to the previous type of sedimentation during the Silurian in Scania, i.e. with dark grey graptolitic shales in the Llandovery and Wenlock and light grey, micaceous graptolitic shales in early-middle Ludlow. The latter deposit, the Colonus Shale, was formed during a relatively short interval, but still it shows the largest thickness of all Silurian deposits, 600—700 m. The Öved-Ramsåsa Beds are probably 300—400 m thick.

STOP 8. ERIKSDAL (and adjacent KURREMÖLLA VALLEY)
(see also pp. 37-41 Kimmerian tectonics)

Erik Norling

Object: Marine post-Hettangian Lower Jurassic; Deltaic and nearshore deposits of Middle Jurassic age (Bajocian-Bathonian); Brackish-marine Upper Jurassic (Kimmeridgian-Portlandian).

Location and geological framework. - Eriksdal is situated some 20 km N of the town of Ystad in the Vomb Basin, which is a narrow, elongated graben surrounded by positive tectonic elements. Its length is approximately 80 km, while its width ranges from 7 km in the northern part to about 11 km in the southern part.

The eastern margin of the Vomb Basin is defined by a major fault, which forms the western boundary of a Lower Palaeozoic plateau (Fig. 10). To the west the basin is bordered by the Romeleåsen Horst, a granitic block which separates the south-west Scanian basin from the Vomb Basin. To the south the basin extends offshore from Scania.

In the Vomb Basin the rock surface is dominantly of Late Cretaceous age (Campanian and/or Early Maastrichtian) with a narrow marginal rim of Upper Triassic and Jurassic strata (Fig. 1). Towards the south-west (in the vicinity of Ystad), minor parts of the rock surface also include Lower Tertiary beds, viz. Danian limestone and Middle to Upper Paleocene glauconitic sandstone and marl.

As indicated by seismic surveys the Vomb Basin is asymmetrical about SE—NW as well as SW—NE directions and is deepest across the eastern boundary fault and in the vicinity of Köpingsberg (Fig. 23).

The Vomb Basin is affected by swarms of faults with dominant trends NW—SE, NE—SW and E—W (cf. Fig. 16). These tectonic zones are believed to have been repeatedly rejuvenated throughout the Mesozoic, at least until early Late Cretaceous time (Kimmerian to Sub-hercynian movements). The large number of faults within the basin have caused the formation of many open and wedge-shaped minor troughs and uplifts. The tectonic movements have also caused significant variations in the total sedimentary thicknesses. In its present shape the Vomb Basin appears to result from inversion movements. The tectonic pattern reflects extensional forces mainly along the length of the trough. This is indicated by the many grabens and horst and the lack of fold structures.

During long periods of uplift in Late Palaeozoic and Triassic times the area now representing the Vomb Basin was subject to deep erosion. Later subsidence along NW—SE trending lineaments was initiated by Kimmerian movements, but reached a maximum in Santonian times. Though the Vomb Basin is framed by Lower Palaeozoic and Triassic rocks, such strata are probably missing in the central parts of the trough. In Snaven-1 and Assmåsa-1, the latter boring located very close to Eriksdal, Middle Jurassic Glass Sand rests immediately on the crystalline basement. In Hammar-1, in the SE part of the basin, Cenomanian glauconitic sandstone succeeds the basement. The maximum depth of the Vomb Basin, to be found in the vicinity of Köpingsberg, is of the order 1 500 m.

Description of the localities

The Jurassic strata to be seen at Eriksdal are more or less vertically tilted or slightly overthrusted. From NE towards SW they include Liassic ferruginous beds (Kurremölla Valley) succeeded by Bajocian "Eriksdal beds", Bathonian Glass Sand, and Kimmeridgian-Portlandian Fyledal Clay (Figs 7 and 43). The post-Liassic beds are exposed in the sand pit of the Fyleverken Company.

Lower Jurassic ferruginous sandstones

The ferruginous sandstones of the Kurremölla Valley include limonitic, chamositic and sideritic sandstones. The limonitic sandstone, commonly yellow to brownish, predominates in the weathering zone, whereas in unweathered position (in cores and fresh outcrops) this type of sandstone is usually replaced by chamositic sandstone. To a lesser extent limonitic sandstones originate from sideritic and calcite cemented sandstones (Hadding, 1929). The Fe content of the local limonites is usually less than 8—10%

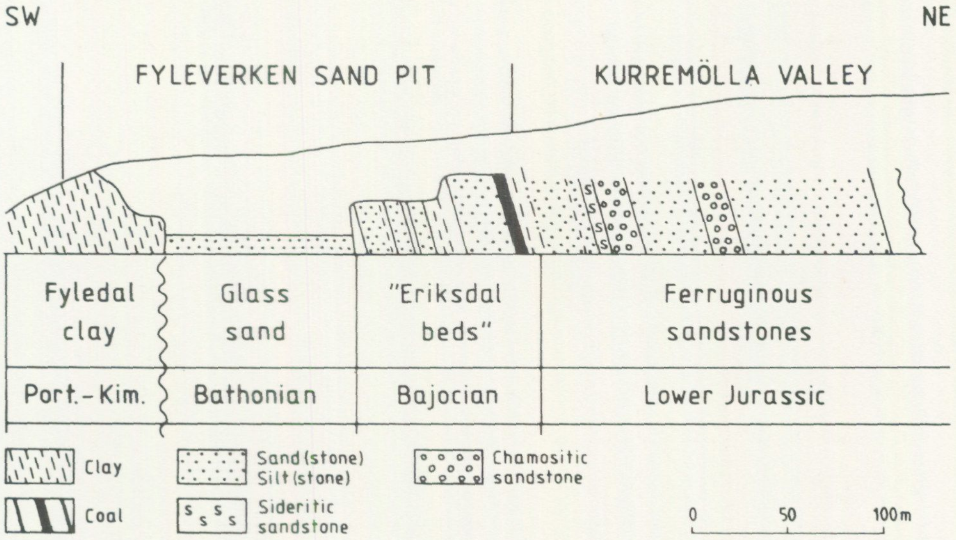


Fig. 43. Schematic section of the Jurassic at Kurremölla - Fyleververken Sand Pit, Eriksdal. Modified after Stenestrom 1943 and Oertli, Brotzen & Bartenstein 1961.

(Hadding 1933). Unweathered the chamositic sandstone is greyish green or dark green, turning rusty when weathered. This type of sandstone contains 10—12 % Fe on an average. In oolitic varieties, the iron content may reach 15—20 % (Hadding 1933).

The sideritic sandstones are usually grey to greyish green and relatively fine-grained. The iron content commonly exceeds 20%.

The oldest Liassic beds of the Kurremölla area have yielded ammonites of the *Oxynoticeras oxynotum* Zone (Upper Sinemurian) according to Reyment (1959). More to the SW in the Kurremölla Valley, Moberg (1888) found evidence of the *Uptonia jamesoni* Zone (Lower Pliensbachian). His ammonite determinations, including those of the zonal denominator, have been verified by Reyment (1959). Today, the ammonite bearing part of the Liassic sequence is poorly exposed.

In spite of repeated and thorough attempts to find fossils, the younger parts of the ferruginous sandstone sequence have not

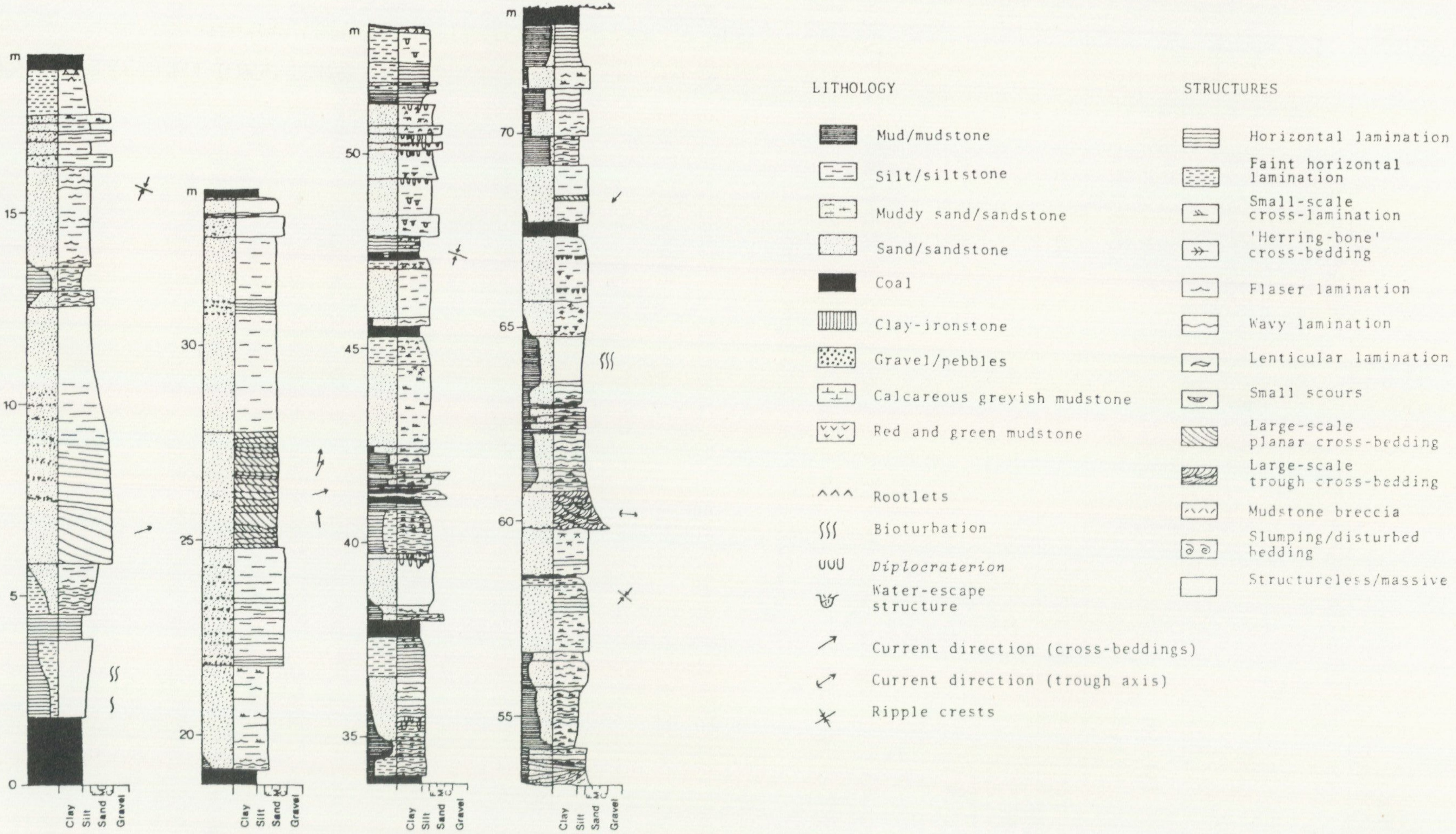

m
0
5
10
15
Clay
Silt
Sand
Gravel
m
20
25
30
m
35
40
45
50
m
55
60
65
70
LITHOLOGY
Mud/mudstone
Silt/siltstone
Muddy sand/sandstone
Sand/sandstone
Coal
Clay-ironstone
Gravel/pebbles
Calcareous greyish mudstone
Red and green mudstone
^^^ Rootlets
ʃʃʃ Bioturbation
UUU Diplocraterion
Water-escape structure
Current direction (cross-beddings)
Current direction (trough axis)
Ripple crests
STRUCTURES
Horizontal lamination
Faint horizontal lamination
Small-scale cross-lamination
'Herring-bone' cross-bedding
Flaser lamination
Wavy lamination
Lenticular lamination
Small scours
Large-scale planar cross-bedding
Large-scale trough cross-bedding
Mudstone breccia
Slumping/disturbed bedding
Structureless/massive

Fig. 44. (above) "Eriksdal beds". Bajocian deltaic sediments. Fyleverken Sand Pit, Eriksdal (After Rolle et al. 1979)

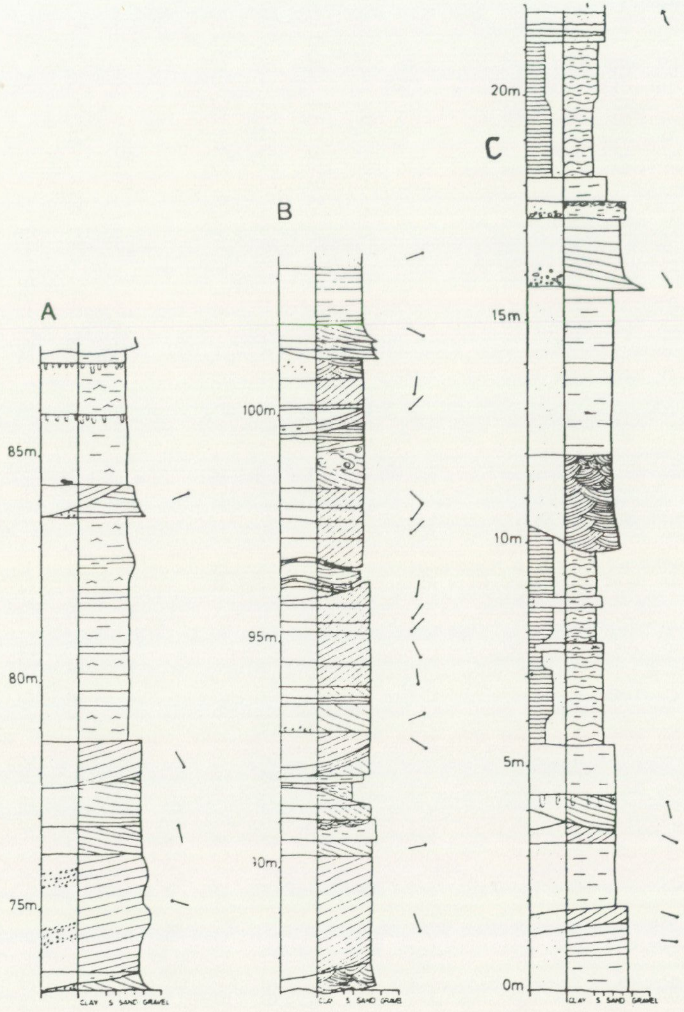


Fig. 45. (right) Glass Sand. Bathonian lagoonal - shallow marine sediments exposed in the Sand Pit of the Fyleverken Company, Eriksdal. (After Rolle et al. 1979).

yielded biostratigraphical tools. On lithostratigraphical grounds, however, it seems most likely that this part of the sequence includes Upper Pliensbachian (Domerian), Toarcian and perhaps also Aalenian strata (Norling 1972).

"Eriksdal beds" (Middle Jurassic)

The "Eriksdal beds", exposed in the sand pit of the Fyleverken Company, comprise alternating clays and sands with several coal-seams regarded as deltaic deposits. Based on palaeobotanical and palynological studies, Tralau (1966, 1968) has given these beds a Bajocian age.

The upper 40 m of the "Eriksdal beds" (total thickness c. 100 m) comprise small cycles of sand, clay and coal (3—5 m), whilst the middle part shows two thicker (15—17 m) coarser-grained cycles (Fig. 44). In the lower of these two cycles a 7—10 m thick cross-bedded sand can be followed for more than 400 m along the strike. Palaeocurrent direction is towards E—ENE. In the upper small-cyclic part a facies analyses shows a strong cyclicity. The general succession is from below: 1) Wavy, thinly rhythmically bedded heteroliths, 2) horizontally laminated fine-grained sand occasionally with *Diplocraterion*, 3) horizontally laminated silt with rootlets, and 4) a coal seam. The latter can be followed for more than 700 m along the strike.

The extensive coal-seams, the marine intercalations, and the cyclicity possibly indicate a delta top environment in a humid, relatively warm climate. The heteroliths were probably deposited by overbank flooding, on levées and in the interdistributary bays, whilst the horizontally laminated sand with *Diplocraterion* suggests deposition on a beach foreshore environment in the seaward part of the delta. Plant growth and accumulation on top of the delta lobe following abandonment resulted in formation of the capping coal-seam (Rolle et al. 1979).

Glass Sand (Middle Jurassic)

The "Eriksdal beds" are succeeded by the Glass Sand dated to the Bathonian by Tralau (1968). This lithostratigraphical unit mainly comprises fine- to medium-grained whitish sand (Fig. 45). The lowest part consists of some 14 m of brownish coarse- to medium-grained sand, low-angle cross-bedded at the bottom and flaser-bedded with *Diplocraterion* horizons near the top. This is followed by whitish cross-bedded sand with thin heteroliths (3 m), sand, clay and silt (2—5 m). The uppermost 20 m of the whitish Glass Sand shows occasional heavy mineral strips and ferruginous concretions resembling trace fossils. The total thickness of the Glass Sand varies from 80 m to 100 m in the sand pit.

The sand with *Diplocraterion* was probably deposited in the beach foreshore environment by migration of sand bars and mega-ripples. The heterolith may reflect deposition in a minor lagoon. The upper part of the Glass Sand is probably also deposited in a beach foreshore environment. The palaeocurrent directions show a tripolar pattern: ENE and WSW, perpendicular to the tectonic trend of the Fennoscandian Border Zone, and SSE parallel to the presumed coastline.

Fyledal Clay (Upper Jurassic)

Between the Glass Sand and the succeeding Fyledal Clay there is a big stratigraphical hiatus including parts of the Bathonian, the whole Callovian and Oxfordian and parts of the Kimmeridgian. In boreholes in W and NW Scania, however, a more complete succession has been cored including marine strata of Upper Bathonian, Callowian and Oxfordian age (Fortuna Marl) and a more complete sequence of the Fyledal Clay than that represented in the Eriksdal area.

The Fyledal Clay at Eriksdal, at least the lower part, is of Kimmeridgian age according to Christensen (1968). These beds have yielded brackish-marine microfossils (ostracodes, foraminifers, charophyte gyronites) and were deposited in the offshore environment.

STOP 9. KOMSTAD AREA

Jan Bergström

Object: Various parts of the Lower and Middle Ordovician.

The base of the Ordovician (Tremadoc) is accessible along a small rivulet at the farm Flagabro, run by Mr. Julius Jönsson and his Polish wife. Just east of a small bridge there is a 1 m thick, grey-coloured and calcilutitic Ceratopyge Limestone, which forms the top of the Tremadoc. This limestone has yielded a fauna including the trilobites *Ceratopyge forficula, Euloma ornatum, Niobe insignis* and *Symphysurus angustatus*, and brachiopods (Tjernvik 1958). The limestone is underlain by a thin sheet of dark Ceratopyge Shale with the phyllocarid crustacean *Ceratiocaris* and brachiopods. Underlying the Ceratopyge Limestone and shale is the 11 m thick Dictyonema Shale, which is an alum shale forming the base of the Tremadoc. This shale is highly bituminous and contains concretions of stinkstone (= bituminous limestone), baryte and pyrite. The total content of C is 11% and of S 2%. The uranium content is low, only some 50—60 g/t (0.005%). The Dictyonema Shale is known for its content of vanadium (around 0.4%), and a water-filled digging 100 m NE of the bridge is the remains of an attempt to extract the vanadium. The fauna is dominated by the graptolite genus *Dictyonema*. The upper part, exposed at Flagabro, is poorly fossiliferous. Towards the SW the section is terminated by a Permo-Carboniferous dolerite dike just on the other side of the bridge.

Some 550 m SSE of Flagabro there is a small limestone quarry at Killeröd. The limestone overlies 23 m of Lower Didymograptus Shale (Tjernvik 1960), which in turn overlies the Ceratopyge Limestone. The limestone itself belongs to the Upper Arenig and is called Komstad Limestone. Here, in its type area, it is around 10 m thick. It is considered as a tongue of the thick orthoceratite limestone, which is characteristic of Öland, Gotland and south-central Sweden. It thins out towards the west to around

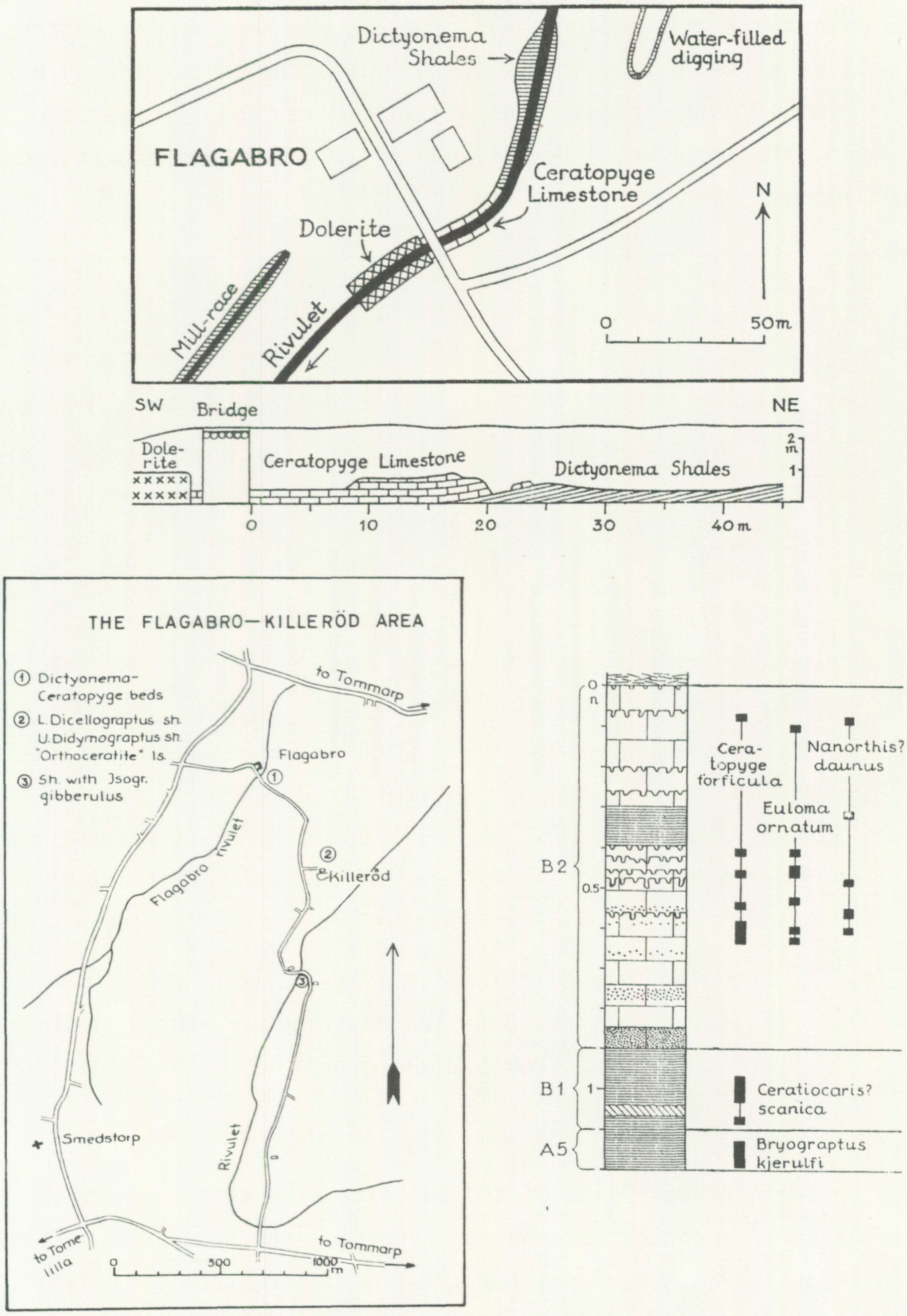


Fig. 46. Maps covering the Flagabro-Killeröd area and section through upper Tremadocian beds at Flagabro. (From Tjernvik 1958 and Tjernvik in Regnéll 1960.)

2 m east of Lund. Tectonic disturbances are seen in the western wall at Killeröd, and in the NE the limestone is cut off by a 27 m wide Permo-Carboniferous dolerite dike. Fossils are rare and poorly preserved. They include trilobites and orthoconic cephalopods.

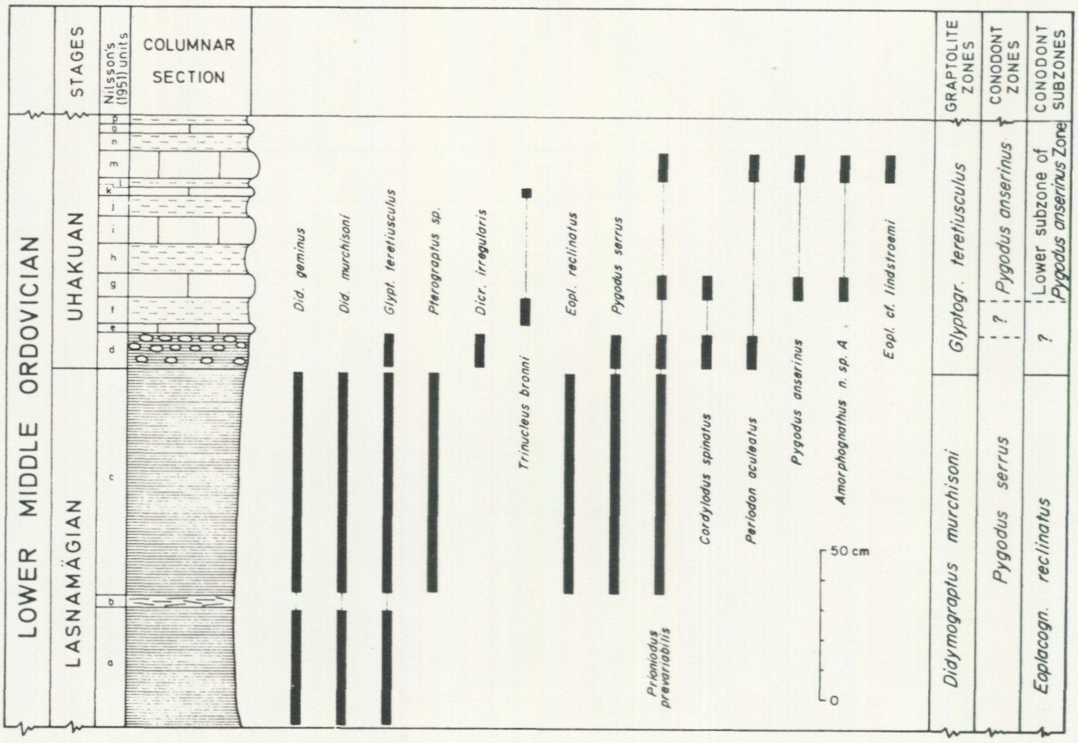


Fig. 47. Lithology and distribution of selected fossils in the Killeröd section. Detailed distribution within units a and c unknown. From S.M. Bergström 1973, incl. data from Nilsson 1952.

On the northwest side of the dolerite dike there is a small exposure of a condensed sequence overlying the Komstad Limestone (Nilsson 1952; S.M. Bergström 1973; S.M. Bergström & Nilsson 1974). At the base there is 1.2 m of dark graptolite shale, the Upper Didymograptus Shale (Figs 4, 47, 48) overlain by 0.12 m of similar Lower Dicellograptus Shale. This sequence is fairly rich in graptolites, including species of *Didymograptus*, *Glyptograptus* and *Climacograptus*. There are also brachiopods and conodonts.

The top of the sequence is formed by 0.7 m of so called Bronni beds, named after the trilobite *Trinucleus bronni*. These beds, distinguished only in southeastern Scania (Nilsson 1952; S.M. Bergström 1974). The rocks are alternating grey mudstone and hard, grey, finely crystalline limestones. The fauna includes a number of trilobites and brachiopods.

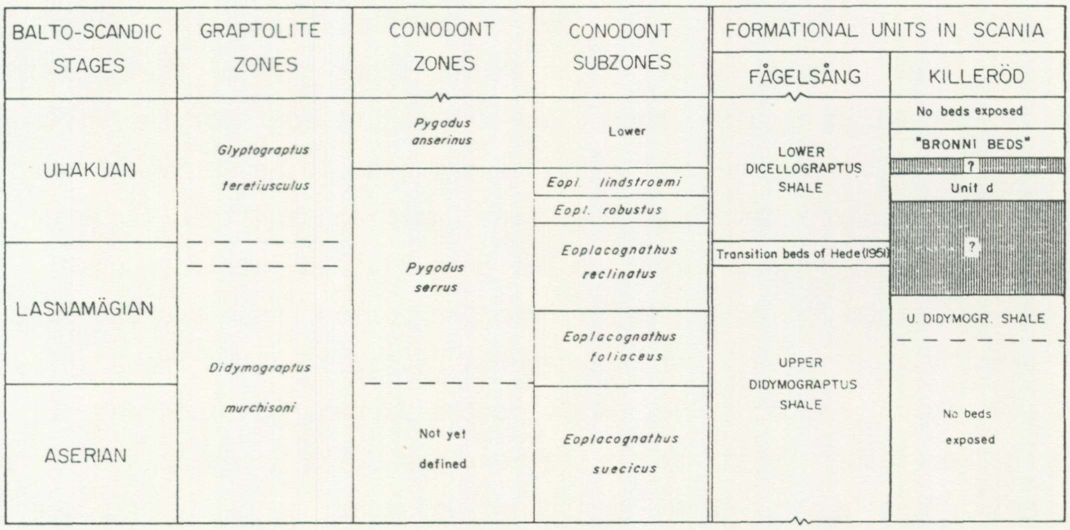


Fig. 48 . Correlation between early Middle Ordovician formational units in Skåne, the Balto-Scandic standard stages, and the graptolite and conodont zonal successions. "Bronni beds" are now distinguished as the Killeröd Formation. From S.M. Bergström 1973.

STOP 10. SIMRISLUND

Jan Bergström

Object: Lower Cambrian and rock carvings.

The Lower Cambrian sandstones are comparatively resistant to denudation and form long stretches of the shoreline in the Simrishamn area in south-eastern Scania. The upper part of the sequence is exposed in a quarry and on the shore just south of the village of Simrislund, where rock carvings are also to be seen.

In the Simrishamn area the Lower Cambrian sandstone sequence below the Norretorp Formation has been divided into four units by Lindström & Staude (1971). From the bottom these are the Lunkaberg, Vik, Brantevik, and Hardeberga (s.str.) units. These units seem to correspond collectively to the Hardeberga Sandstone of the Romeleåsen Horst and to the Nexø and Balka Sandstones of Bornholm. Recently the term Simrishamn Sandstone has been introduced to cover this sequence (Shaikh & Skoglund 1974), but the term Hardeberga Sandstone has clear priority, is in general use, and is now accepted also for Bornholm (cf. Bergström & Ahlberg 1981, p. 193). Thus the quarry at Simrislund exposes the uppermost quartzarenitic member of the Hardeberga Sandstone. The rock is very similar to that at Hardeberga (see p. 55). At the entrance of the quarry there is a small conical depression of the kind described from north of Simrishamn (Lindström 1967).

The boundary between the Hardeberga Sandstone and the overlying Norretorp Formation is exposed on the shore. The boundary is much more distinct than at Hardeberga. At places along the coast there is evidence of an event at the transition (Lindström 1972). This event may have included frost binding of the underlying quartz sand, erosion from running water and ice, deposition of frozen blocks of sand, and deposition of a sheet of heavy minerals.

The Norretorp Formation is only a few metres thick at this locality. It is greener than the same formation at Hardeberga (where it is around 15 m thick) and therefore reminds one more of the probably corresponding "green siltstones" (60 m thick) of Bornholm. The colour is highly influenced by the variable content of glauconite and phosphate. The locality has yielded a brachiopod species, the trilobite *Schmidtiellus mickwitzi torelli* (see Bergström 1973) and trilobite type trace fossils.

Overlying strata belonging to the top of the Lower Cambrian (Rispebjerg and Gislöv Formations) follow in the water. Sections through this interval were recently described from localities further south along the coast (de Marino 1980a; Bergström & Ahlberg 1981). At the entrance of the above-mentioned quarry there is a severely circumscribed surface with bronze-age rock carvings. The sandstone yields nice polished surfaces and seems to have been much appreciated for rock-carving purposes. There are several known examples in the Simrishamn area. The carvings are supposed to have a symbolic character. Common objects in such carvings are men, axes, ships, sun-wheels and small pits.

REFERENCES

Ahlberg, P. & Bergström, J., 1978: Lower Cambrian ptychopariid trilobites from Scandinavia. Sver. geol. Unders. Ser. Ca, No. 49, 41 pp.

Berggren, W.A., 1960: Biostratigraphy, planktonic Foraminifera and the Cretaceous-Tertiary boundary in Denmark and southern Sweden. Int. Geol. Congr. XXI Sess., Sect. 5, 181—192.

Berggren, W.A., 1962a: Some planktonic Foraminifera from the Maastrichtian and type Danian stages of southern Scandinavia. Stockh. Contr. Geol. 9 (1), 1—106.

Berggren, W.A., 1962b: Stratigraphic and taxonomic-phylogenetic studies of Upper Cretaceous and Palaeogene planktonic Foraminifera. Stockh. Contr. Geol. 9 (2), 107—129.

Bergström, J., 1970: *Rusophycus* as an indication of early Cambrian age. Geological Journal, Special Issue 3, 35—42.

Bergström, J., 1973: Classification of olenellid trilobites and some Balto-Scandian species. Norsk Geol. Tidsskr. 53, 283—314.

Bergström, J., 1981a: Kristianstadtrakten genom årmiljonerna. Skånes Naturvårdsförbunds Årsskrift 1981, 7—16.

Bergström, J., 1981b: Lower Cambrian shelly faunas and biostratigraphy in Scandinavia. In M.E. Taylor (ed.): Short Papers for the Second International Symposium on the Cambrian System 1981. U.S. Geological Survey Open-File Report 81—743, 22—25.

Bergström, J., 1982: Scania. In Bruton, D.L. & Williams, S.H. (eds): Field excursion guide, IV Int. Symp. Ordovician System. Palaeont. Contrib. Univ. Oslo 279, 184—197.

Bergström, J. & Ahlberg, P., 1981: Uppermost Lower Cambrian biostratigraphy in Scania, Sweden. Geol. Fören. Stockh. Förh. 103, 193—214.

Bergström, S.M., 1973: Correlation of the late Lasnamägian Stage (Middle Ordovician) with the graptolite succession. Geol. Fören. Stockh. Förh. 95, 9—18.

Bergström, S.M. & Nilsson, R., 1974: Age and correlation of the Middle Ordovician bentonites on Bornholm. Bull. geol. Soc. Denmark 23, 27—48.

Berthelsen, F., 1978: The Upper Triassic-Lower Jurassic Vinding and Gassum Formations of the Norwegian-Danish Basin. Danm. geol. Unders. Ser. B, No. 3.

Brotzen, F., 1940: Flintrännans och Trindelrännans geologi (Öresund). Sver. geol. Unders., Ser. C, No. 435, 21 pp.

Brotzen, F., 1944: De geologiska resultaten från borrningarna vid Höllviken. Sver. geol. Unders. Ser. C, No. 465, 65 pp.

Brotzen, F., 1945: De geologiska resultaten från borrningarna vid Höllviken. Preliminär rapport. I: Kritan. Sver. geol. Unders. Ser. C, No. 465, 64 pp.

Brotzen, F., 1948: The Swedish Paleocene and its Foraminiferal fauna. Sver. geol. Unders. Ser. C, No. 493, 140 pp.

Brotzen, F., 1950: De geologiska resultaten från borrningarna vid Höllviken. II. Undre kritan och trias. Sver. geol. Unders. Ser. C, No. 505, 48 pp.

Brotzen, F., 1959: On *Tylocidaris* species (Echinoidea) and the stratigraphy of the Danian of Sweden. Sver. geol. Unders. Ser. C, No. 571, 1—81.

Bylund, G., 1974: Palaeomagnetism of dykes along the southern margin of the Baltic Shield. Geol. Fören. Stockh. Förh. 96, 231—235.

Bölau, E., 1951: Recent tectonics and the Rhaetic sedimentation in N.W. Scania. Geol. Fören. Stockh. Förh. 73, 434—444.

Bölau, E., 1959: Der Südwest- und Südostrand des Baltischen Schildes (Schonen und Ostbaltikum). Geol. Fören. Stockh. Förh. 81, 167—230.

Bölau, E., 1973: Die Kimmerischen Bewegungen im tektonischen Bilde Schonens. Geol. Fören. Stockh. Förh. 95, 165—180.

Bölau, E., 1973: Pankarpslager (lias beta). Stratigrafiska definitioner och facies. Geol. Fören. Stockh. Förh. 95, 268—272.

Cheetham, A., 1971: Functional morphology and biofacies distribution of Cheilostome Bryozoa in the Danian Stage (Paleocene) of southern Scandinavia. Smiths. Contr. Paleobiol. 6, 87 pp.

Christensen, O.B., 1968: Some deposits and microfaunas from the Upper Jurassic in Scania. Sver. geol. Unders. Ser. C, No. 632, 46 pp.

Grahn, Y., 1978: Chitinozoan stratigraphy and palaeoecology at the Ordovician-Silurian boundary in Skåne, southernmost Sweden. Sver. geol. Unders. Ser. C, No. 744, 16 pp.

Gravesen, P. 1977: Nye iagttagelser på Kridtlokaliteten Rödmölla/ Tosterup i sydøst-Skåne. Dansk Geol. Fören., Årsskr. 1976, 75——83.

Gustafsson, O. & Norling, E., 1973: New finds of Middle Paleocene (Selandian) strata in Skåne, southern Sweden. A preliminary report. Geol. Fören. Stockh. Förh. 95, 253—260.

Guy-Ohlson, D., 1971: Palynological investigations in the Middle Jurassic of the Vilhelmsfält boring, southern Sweden. Publ. Inst. Min. Palaeont. Quat. Geol., Lund, No. 168, 104 pp.

Guy-Ohlson, D., 1976: Additional palynomorphs from the Middle Jurassic of the Vilhelmsfält boring, southern Sweden. Stockh. Contr. Geology 30:3, 81—94.

Guy-Ohlson, D., 1978: Jurassic biostratigraphy of three borings in NW Scania. Sver. geol. Unders., Rapp. o. Medd. No. 11, 41 pp.

Guy-Ohlson, D., 1981: Rhaeto-Liassic palynostratigraphy of the Valhall bore No. 1, Scania. Geol. Fören. Stockh. Förh. 103, 233—248.

Guy-Ohlson, D., 1982 (in press): Biostratigraphy of the Jurassic-Cretaceous unconformity at Kullemölla, SE Scania. Sver. geol. Unders. Ser. Ca.

Hadding, A., 1929: The pre-Quaternary sedimentary rocks of Sweden: III. The Paleozoic and Mesozoic sandstones of Sweden. Lunds Univ. Årsskr., N.F. 2, 25(3), 287 pp.

Hadding, A., 1958: The pre-Quaternary sedimentary rocks of Sweden: IV. Cambrian and Ordovician limestones. Lunds Univ. Årsskr., N.F. 2, 54(5), 262 pp.

Hansen, J.M., 1977: Dinoflagellate stratigraphy and echinoid distribution in Upper Maastrichtian and Danian deposits from Denmark. Bull. geol. Soc. Denmark 26, 1—26.

Hansen, K., 1937: Sammenlignende Studier över Kambriet i Skåne og paa Bornholm. Medd. dansk Geol. Foren. 9, 151—182.

Hede, J.E., 1915: Skånes colonusskiffer. I. Lunds Univ. Årsskr. N.F., Afd. 2, 26(6), 1—66. Also as K. Fysiogr. Sällsk. Handl. N.F., 11(6).

Hessland, I., 1950: Investigations of the Senonian Kristianstad district, S. Sweden. 2. Sedimentology and lithogenesis of the Åhus Series. Bull. geol. Inst. Univ. Uppsala 34, 45—106.

Hjelmqvist, S., 1940: Some post-Silurian dykes in Scania and problems suggested by them. Sver. geol. Unders. Ser. C, 430, 32 pp.

Holland, B. & Gabrielsson, J., 1979: Guide to Limhamn Quarry. in: Birkelund, T. & Bromley, R.F., (eds): Cretaceous-Tertiary boundary events. Symposium 18—24 September 1979. I. The Maastrichtian and Danian of Denmark. 142—152.

Holland, B., Stridsberg, S. & Bergström, J., 1978: Confirmation of the reconstruction of *Aptychopsis*. Lethaia 11, p. 144.

Jeppsson, L., 1974: Aspects of Late Silurian conodonts. Fossils and Strata 6, 78 pp.

Kjellström, G. & Hansen, J.M., 1981: Dinoflagellate biostratigraphy of the Cretaceous-Tertiary boundary in southern Scandinavia. Geol. Fören. Stockh. Förh. 103, 271—278.

Klingspor, I., 1973: A preliminary report on the dating by the K/Ar method of a basalt neck at Göbnehall, southern Sweden. Geol. Fören. Stockh. Förh. 95, 287—289.

Klingspor, I., 1976: Radiometric age-determinations of basalts, dolerites and related syenite in Skåne, southern Sweden. Geol. Fören. Stockh. Förh. 98, 195—216.

Kornfält, K.-A., Bergström, J., Carserud, L., Henkel, H. & Sundquist, B., 1978: Beskrivning till berggrundskartan och flygmagnetiska kartan Kristianstad SO. Sver. Geol. Unders. Ser. Af., No. 121, 120 pp.

Larsson, K., 1979: Silurian tentaculitids from Gotland and Scania. Fossils and Strata 11, 180 pp.

Laufeld, S., Bergström, J. & Warren, P.T., 1975: The boundary between the Silurian Cyrograptus and Colonus Shales in Skåne, southern Sweden. Geol. Fören. Stockh. Förh. 97, 207—222.

Lidmar-Bergström, K., 1982: Pre-Quaternary geomorphological evolution in southern Fennoscandia. Sver. geol. Unders. Ser. C, No. 785, 202 pp.

Lind, A., Solyom, Z., & Johansson, I., 1981: The question of chemical homogeneity among basic hypabyssals along the Scandinavian Protogine Zone. Sver. geol. Unders. Ser. C, No. 780, 36 pp.

Lindström, M., 1960: On some sedimentary and tectonic structures in the Ludlovian Colonus Shale of Scania. Geol. Fören. Stockh. Förh. 82, 319—341.

Lindström, M., 1967: "Funnel Grabens" and Early Paleozoic tectonism in South Sweden. Geol. Soc. Am. Bull. 78, 1137—1154.

Lindström, M., 1972: Cold age sediment in Lower Cambrian of South Sweden. Geologica et Palaeontologica 6, 9—23.

Lindström, M., & Staude, H., 1971: Beitrag zur Stratigraphie der unterkambrischen Sandsteine des südlichsten Skandinaviens. Geologica et Palaeontologica 5, 1—7.

Lund, J., 1977: Rhaetic to Lower Liassic palynology of the onshore south-eastern North Sea Basin. Danm. geol. Unders. II Raekke 109, 128 pp.

Lundegren, A., 1935: Kristianstadsområdets kritbildningar. Geol. Fören. Stockh. Förh. 56, 126—313.

Lundqvist, T., 1979: The Precambrian of Sweden. Sver. geol. Unders. Ser. C, No. 768, 87 pp.

Malmgren, B., 1974: Morphometric studies of planktonic foraminifers from the type Danian of southern Scandinavia. Stockh. Contr. Geol. 29, 126 pp.

Malmgren, B., 1976: Size and shape variation in the planktonic foramifer *Heterohelix striata* (Late Cretaceous, Southern Scandinavia). Math. Geol. 8 (2), 165—182.

de Marino, A., 1980a: The upper Lower Cambrian strata south of Simrishamn, Scania, Sweden: a transgressive-regressive shift through a limestone sequence. Sver. Geol. Unders. Ser. C, No. 771, 22 pp.

de Marino, A. 1980b: Sandstones and phosphatized calcareous sediments of the Lower Cambrian Rispebjerg Sandstone, Bornholm, Denmark. Geol. Surv. Denmark, II Ser. No. 113, 39 pp.

Martinsson, A., 1967: The succession and correlation of ostracode faunas in the Silurian of Gotland. Geol. Fören. Stockh. Förh. 89, 350—386.

Michelsen, O., 1978: Stratigraphy and distribution of Jurassic deposits of the Norwegian-Danish Basin. Danm. geol. Unders. Ser. B, No. 2.

Moberg, J.C., 1910: Guide for the principal Silurian districts of Scania (with notes on some localities of Mesozoic beds). Geol. Fören. Stockh. Förh. 32, 45—194.

Mulder, F.G., 1971: Paleomagnetic Research in some parts of Central and Southern Sweden. Sver. geol. Unders. Ser. C, No. 653, 56 pp.

Nathorst, A.G., 1887: Till frågan om de skånska dislokationernas ålder. Geol. Fören. Stockh. Förh. 9, 74—130.

Nilsson, R., 1952: Till kännedomen om ordovicium i sydöstra Skåne. Geol. Fören. Stockh. Förh. 73, 682—694.

Nilsson, R., 1977: A boring through Middle and Upper Ordovician strata at Koängen in western Scania, southern Sweden. Sver. geol. Unders. Ser. C, No. 733, 58 pp.

Nilsson, R., 1979: A boring through the Ordovician-Silurian boundary in western Scania, south Sweden. Sver. geol. Unders. Ser. C, No. 766, 18 pp.

Norling, E., 1970: Jurassic and Lower Cretaceous stratigraphy of the Rydebäck-Fortuna borings in southern Sweden. Geol. Fören.

Stockh. Förh. 92, 261—287.

Norling, E., 1972: Jurassic stratigraphy and foraminifera of western Scania, southern Sweden. Sver. geol. Unders. Ser. Ca, No. 47, 120 pp.

Norling, E., 1973: Fossila foraminiferer. Fauna och Flora 68, 126—134.

Norling, E., 1978: In E. Daniel: Beskrivning till jordartskartan Höganäs NO/Helsingborg NV. Berggrunden. Sver. geol. Unders. Ser. Ae 25, 92 pp.

Norling, E., 1978: Den sedimentära berggrunden. In O. Gustafsson: Beskrivning till hydrogeologiska kartbladet Trelleborg NO/Malmö SO. pp. 13—22, 59, 60. Sver. geol. Unders. Ser. Ag 6, 72 pp.

Norling, E., 1980: Den sedimentära berggrunden. In B. Ringberg: Beskrivning till jordartskartan Malmö SO, pp. 25—35, 164, 165. Sver. geol. Unders. Ser. Ae 38, 179 pp.

Norling, E., 1981: Upper Jurassic and Lower Cretaceous geology of Sweden. Geol. Fören. Stockh. Förh. 103, 253—269.

Norling, E. & Skoglund, R., 1977: Der Südwestrand der Osteuropäischen Tafel im Bereich Schwedens. Z. Angew. Geol. 23, 449—458.

Norling, E., Wikman, H., Sivhed, U. & Karis, L., 1981: Berggrundskartan 3B Höganäs NO/3C Helsingborg NV. Sver. geol. Unders. Ser. Af 129.

Nyers, A. & Nilsson, R., 1973: The Lithology, fauna and stratigraphy of two drill cores from the Upper Wenlock in western Skåne, southern Sweden. Geol. Fören. Stockh. Förh. 95, 229—235.

Priem, H.N.A., Mulder, F.G., Boelrijk, N.A.I.M., Hebeda, F.H., Verschure, R.H. & Verdurmen, E.A.T.H., 1968: Geochronological and palaeomagnetic reconnaissance survey in part of central and southern Sweden. Phys. Earth Planet. Interiors Vol. 1, 373—380.

Prinzlau, I. & Larsen, O., 1972: K/Ar age determinations on alkaline olivine basalts from Skåne, south Sweden. Geol. Fören. Stockh. Förh. 94, 259—269.

Regnéll, G., 1960: The Lower Palaeozoic of Scania. In G. Regnéll & J.E. Hede: The Lower Palaeozoic of Scania; The Silurian of Gotland. Int. Geol. Congr., XXI Session, Norden 1960, Guide to Excursions Nos A22 and C17, 3—43.

Reyment, R.A., 1959: On Liassic ammonites from Skåne, southern Sweden. Stockholm Contrib. Geol. 2:6, 103—157.

Reyment, R.A., 1969a: Upper Sinemurian (Lias) at Gantofta Skåne. Geol. Fören. Stockh. Förh. 91, 208—216.

Reyment, R.A., 1969b: A note on *Promicroceras*. Geol. Fören. Stockh. Förh. 91, 440—442.

Ringberg, B., in press: Beskrivning till jordartsgeologiska kartbladet Helsingborg SO (Description to the Quaternary map Helsingborg SO). Sver. geol. Unders. Ser. Ae 51.

Russel, M.J. & Smythe, D.K., 1978: Evidence for an Early Permian oceanic rift in the northern North Atlantic. in: Neumann, E.-R. & Ramberg, I.B.(eds): Petrology and Geochemistry of Continental Rifts, 173—179.

Shaikh, N.A. & Skoglund, R., 1974: The sandstone sequence at Listarum: A contribution to the stratigraphy of the Lower Cambrian in Skåne, southern Sweden. Geol. Fören. Stockh. Förh. 96, 429—433.

Sivhed, U., 1977: A Lower Jurassic ostracode fauna in the Gantofta brick pit, Skåne, southern Sweden. Sver. geol. Unders. Ser C, No. 730, 31 pp.

Sivhed, U., 1980: Lower Jurassic ostracodes and stratigraphy of western Skåne, southern Sweden. Sver. geol. Unders. Ser. Ca, No. 50, 85 pp.

Sivhed, U., 1981: Stratigraphy of the Gantofta-Katslösa area in Scania, Sweden. Geol. Fören. Stockh. Förh. 103, 249—252.

Sorgenfrei, T. & Buch, A., 1964: Deep tests in Denmark 1935—1959. Danm. geol. Unders. II R. 36, 146 pp.

Stille, H., 1924: Grundfragen der vergleichenden Tektonik. Borntraeger. Berlin.

Tjernvik, T., 1958: The Tremadocian beds at Flagabro in southeastern Scania. Geol. Fören. Stockh. Förh. 80, 259—276.

Tjernvik, T., 1960: The Lower Didymograptus Shales of the Flagabro Drilling Core. Geol. Fören. Stockh. Förh. 82, 203—217.

Tralau, H., 1973: En palynologisk åldersbestämning av vulkanisk aktivitet i Skåne. Fauna och Flora 1973, No. 4, 121—125.

Troelsen, J.C., 1957: Some planktonic foraminifera of the type Danian and their stratigraphic importance. Bull nat. Mus. 215, 125—131.

Troedsson, G.T., 1917: En skärning i Fågelsångstraktens undre kambrium. Geol. Fören. Stockh. Förh. 39, 603—634.

Troedsson, G.T., 1928: Yttrande med anledning av B. Asklunds föredrag om strandflaten på Sveriges västkust. Geol. Fören. Stockh. Förh. 50, 808—810.

Troedsson, G.T., 1932: Några tektoniska och stratigrafiska problem i Skåne. Geol. Fören. Stockh. Förh. 54, 220—226.

Troedsson, G.T., 1940: Om Höörs Sandsten. Geol. Fören. Förh. 62, 245—283.

Troedsson, G.T., 1942: Bidrag till kännedomen om Kågerödsformationen i Skåne. Geol. Fören. Stockh. Förh. 64, 289—328.

Troedsson, G.T., 1950: On rhythmic sedimentation in the Rhaetic-Liassic beds of Sweden. Int. Geol. Congr. "Report of the Eighteenth Session Great Britain 1948", Part IV, 64—72.

Troedsson, G.T., 1951: On the Höganäs series of Sweden. Lunds Univ. Årsskr. N.F. 2, 47 (1), 268 pp.

Westergård, A.H., 1942: Stratigraphic results of the borings through the Alum Shales of Scania made in 1941—1942. Lunds Geol.-Min. Inst., Medd. No. 100, 1—20.

Westergård, A.H., 1944: Borrningar genom Skånes alunskiffer 1941—42. Sver. geol. Unders. Ser. C, No. 459, 45 pp.

Vidal, G., 1981: Microplaeontology and biostratigraphy of the Lower Cambrian sequence in Scandinavia. In: Taylor, M.E. (ed.) Short Papers for the Second International Symposium on the Cambrian System 1981. U.S. Geological Survey Open-File Report 81 743, 232—235.

Voigt, E., 1930: Der Kippschollenbau der Halbinsel Schonen. Zeitschr. Geschiebeforschung 6.

Ziegler, P.A., 1975: Geologic evolution of North Sea and its tectonic framework. Bull. Am. Assoc. Petroleum Geol. 59, 1073—1097.

Ziegler, P.A., 1978: North-western Europe. Tectonics and Basin Development. Geologie en Mijnbouw 57(4), 589—626.

PRISKLASS C
Distribution
LiberKartor
S-162 89 VÄLLINGBY

Fotosats: ORD & FORM AB
Tryck: Offsetcenter AB
Uppsala 1982

ISBN 91-7158-274-6
ISSN 0348-1352