THE ORDOVICIAN OF THE OSLO REGION
A SHORT HISTORY OF RESEARCH

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INTRODUCTION

The Oslo Region (Oslofeltet) is not an administrative unit but a term introduced by geologists. At first referred to as 'Christianias Overgangs-Territorium' (the 'overgang' or transition relating to geological age) or 'Christiania-territoriet' (Keilhau 1826), it later became known as 'Kristianiafeltet' and finally 'Oslofeltet' when the old name of Oslo was reintroduced for the capital in 1925.

The Oslo Region varies in width from 40 to 75 km and extends a distance of approximately 115 km both north and south of Oslo, which is situated at its eastern border. The region is fault controlled (Oslo Graben) and covers an area of roughly 10 000 square km. It is bordered by Precambrian in the west and east and by the Caledonian nappe region in the north. Within the region, Upper Palaeozoic, mostly igneous, rocks are slightly greater in areal extent than the Lower Palaeozoic sedimentary rocks. Ordovician rocks cover around 2 000 square km and crop out in eleven districts established by Størmer (1953).

THE ORDOVICIAN SYSTEM IN THE OSLO REGION

In the early 1800's, strata now assigned to the Ordovician were not distinguished as a separate unit, but were included in the 'Uebergangs-gebirge' (transitional rocks), a concept introduced in Germany in the late 1790's by Abraham G. Werner for rocks between the 'Urgebirge' (ancient rocks) and the 'Flötzgebirge' (Coal Measures and younger). Thus the German geologist von Buch (1810), after having travelled in Scandinavia, assigned all the rocks of the Oslo Region to the 'Uebergangs-formation'. Heyerdahl (1811), curate in Toten, correspondingly called

such rocks the 'Overgangs-Bjergene'. In 1844, Murchison visited Christiania (Oslo) and recognized the presence of both the Lower and Upper division of his newly erected Silurian System, the Lower Silurian including what was later to become the Ordovician and most of the Cambrian. Kjerulf (1855) adopted the terms Upper and Lower Silurian and soon after (Kjerulf 1857) gave reasons why the 'Uebergangsformation' should be discarded and British terms introduced. In a later text-book, Kjerulf (1878) listed three formations, viz. Primordial or Cambrian (including also late Precambrian strata north of the Oslo Region), Lower Silurian and Upper Silurian. Brøgger (1882) continued to regard the Primordial as Silurian and following Barrande, distinguished between the first Silurian or Primordial (= Cambrian), second Silurian (= Ordovician) and third Silurian fauna. In 1887, he loosely applied the term 'Middle Silurian' to beds with the second Silurian fauna and only later (Brøgger 1896) did he advocate the use of the names Cambrian and Ordovician. Following this example, Bjørlykke (1898) used the name Cambrian but regarded the overlying Lower Palaeozoic strata as 'true Silurian'. Thus arose the term Cambro-Silurian still used figuratively today. The term Middle Silurian was reintroduced by Kiær (1901), now in a restricted sense (= uppermost Ordovician). Holtedahl was the first Norwegian geologist to use the term Ordovician, in a publication dealing with fossils from the Canadian Arctic, and later (Holtedahl 1916) applied it to rocks from the Oslo Region.

The boundaries applied to the Ordovician System in Scandinavia developed from boundaries used before the system was accepted. Brøgger (1882) placed a major boundary above the Dictyonema Shale, at the transition from the first to the second Silurian fauna as perceived by him. In Sweden, Moberg (1901) suggested a boundary between the Cambrian and 'Lower Silurian' at the base of the Dictyonema Shale. This is the lower boundary of the Ordovician applied in Scandinavia today. International agreement is still awaited on this boundary as well as that of the upper. Until now the latter has remained remarkably stable and uncontroversial in the Oslo Region, being that between the Lower and Upper Silurian as recognized by Murchison in 1844.

A tripartite division of the Ordovician in the Oslo Region into Lower, Middle and Upper was consolidated by Størmer (1953), who grouped the

Ordovician units of the Etage classification into five local series (Fig. 1), admitting that an earlier attempt (Størmer 1934) to make use of British nomenclature had been premature. In later years, attempts have been made to correlate with the British Standard sections or with that established for eastern Baltoscandia more directly, abandoning the Etage units.

THE ETAGE CLASSIFICATION

'Etage', from French étage (level, floor), was adopted as a stratigraphical term in various European countries in the last century, and for the Lower Palaeozoic succession in the Oslo area by Kjerulf (1857). The etage classification as applied to the Oslo Region was adjusted and refined through the years to comprise ten main etage units with numerous sub-units. They were given 'shorthand symbols' of Arabic numerals followed by Roman and Greek letters (e.g. the Ceratopyge Limestone was given the symbol 3aγ, denoting that it was the third unit (indicated by γ) of the Ceratopyge Beds (3a) of the Lower Ordovician (Etage 3) — see Fig. 1. Some etage units are lithostratigraphical, such as a limestone (e.g. Megistaspis Limestone, 3cα) between two shales. In other cases, one or both boundaries are defined on palaeontological evidence. Thus the Lower Didymograptus Shale (3b) was subdivided into smaller units (3bα-3bδ) according to fossil content.

Upper Ordovician 4c-5b	Tretaspis Series (4c-5b)
Middle Ordovician 4a-4b	Chasmops Series (4aβ- 4bδ) Ogygiocaris Series (4aα)
Lower Ordovician 2e-3c	Asaphus Series (3b-3c) Ceratopyge Series (2e-3a)

Figure 1. Outline of the etage classification of the Ordovician in the Oslo Region.

The unit symbols, first used within restricted areas, were later applied to other parts of the Oslo Region. Outside the type areas, the symbols were normally used in a chronostratigraphical sense. Where originally applied to biostratigraphical units, especially in the Cambrian, the symbols are still practical. In the Ordovician and Silurian, where many symbols were originally based on lithostratigraphical units, changing views on correlation and other factors have led to confusion, and the etage symbols are now being discarded. Nevertheless, their extensive use in literature, on museum labels and in notebooks can hardly be ignored, and with critical use they can convey important locality and stratigraphical information.

EXTRACTS FROM THE HISTORY OF RESEARCH

An Ordovician fossil from the Oslo Region was the first of its kind to be described from Norway. In a publication from 1781, the Danish scientist Morten Thrane Brünnich (1737-1827) described a trilobite species named Trilobus dilatatus (= Ogygiocaris dilatata) and assigned it to the Trilobita, a name introduced only ten years earlier by Walch (1771). Brünnich did not figure any of his specimens but his description of a dorsal shield from Fossum near Skien was so detailed that the specimen could be recognised and selected as a lectotype (Henningsmoen 1960). The specimen is now in the collections of the Geological Museum, Copenhagen. At this time the kingdoms of Denmark and Norway were united, Denmark being the leading nation and Copenhagen the administrative centre. Civil servants were moved from one country to the other and Brünnich spent much of his life as an administrator at the Kongsberg Silver Mines in Norway. However, he longed to do research at the University of Copenhagen and returned there as soon as the union between Norway and Denmark was broken in 1814.

The first illustrations of Norwegian fossils, two trilobites and two 'orthoceratites' from the Ordovician of Eiker, were published in 1784 by Professor in Theology Hans Strøm (1726-1797). He remarked that cephalopods "are seen in thousands sitting on the outside of limestone rocks in a disorderly and criss-cross fashion" (transl.), a vivid description of certain surfaces of the Orthoceras Limestone.

Little else was published on the Ordovician at that time, the Kongsberg Bergseminar (1757-1814) restricting its attention to the mining value of the Oslo Region (Dons 1978).

In the early 1800's, rising national pride in Norway led to the foundation in 1811 of the first Norwegian university (Det kongelige Fredriks Universitet, Universitetet i Oslo from 1939). Until then, the University of Copenhagen (founded 1478) had been the only university in Denmark and Norway. At the new university, geological research expanded rapidly in spite of severe economic problems. In relation to studies in the Oslo Region, Balthazar Mathis Keilhau (1797-1858), Professor in 'The Rock Sciences', published the first geological map of the Region in 1838. There was no chair in palaeontology, but trilobites were described by Christian Peter Bianco Boeck (1798-1877), Professor in Physiology, Comparative Anatomy and Veterinary Sciences from 1840, Hans Morten Thrane Esmark (1801-1882), Minister in Brevik, and by Michael Sars (1805-1869), clergyman and from 1854 Professor in Zoology (see Størmer 1940).

The early 1800's were stormy years. Following the Napoleonic Wars, the Kiel peace treaty of 1814 required the King of Denmark and Norway to cede Norway to Sweden. After negotiations, Norway entered a union with Sweden in the same year, which lasted until 1905, when Norway became independent. Friendships between Nordic countries slowly grew and a meeting of Scandinavian scientists held in Gothenburg in 1839 was the first of many. Roderick I. Murchison was invited to a similar meeting held in Christiania (Oslo) in 1844 and "On an excursion in the vicinity of Oslo he was struck by the striking similarity in stratigraphy and tectonics between the Oslo Region and Wales" (Størmer 1953, 46).

Theodor Kjerulf (1825-1888) succeeded Keilau as professor in 1858. He and Tellef Dahll (1825-1893), Superintendent of Mines from 1872, did much to unravel the geology of southern Norway. They took the initiative to establish the Norwegian Geological Survey in 1858, with Kjerulf as director and Dahll as his only full-time member of staff. Kjerulf (1857) laid the foundation of the Lower Palaeozoic stratigraphy in Norway which included contributions by Dahll.

The first comprehensive study of the Ordovician of the Oslo Region was by Waldemar Christopher Brøgger (1851-1940) who, having already published on Middle Cambrian fossils and sections at Krekling, Eiker (Brøgger 1878), turned his attention to the younger parts of the section. A comprehensive study (Brøgger 1882) on the Upper Cambrian and Lower Ordovician was completed before moving to Stockholm in the same year to become Professor of Geology and Mineralogy, a position he held until 1890 when he returned to a similar office in Oslo. Although most of his studies concentrated on other fields in geology, later papers included one on the Lower Palaeozoic stratigraphy and tectonics of the Skien-Langesund area (Brøgger 1884) and another covering in detail the Ordovician stratigraphy of islands near Oslo. His last Ordovician paper (Brøgger 1896), on the distribution of the Euloma-Niobe fauna in Europe, was written while temporarily in bed!

A contemporary of Brøgger was Hans Reusch (1852-1922) who became director of the Norwegian Geological Survey in 1888. Although his research was concentrated on areas outside the Oslo Region, he published several small 'notes' on the stratigraphy and tectonics of Ordovician strata (e.g. Reusch 1883). It has been said that Brøgger saw the outcrops in two dimensions and Reusch in three, referring to the latter's many published block diagrams. Reusch founded a geological club which, in 1905, became the Geological Sociey of Norway with himself as the first president.

Johan Aschehoug Kiær (1869-1921) became the first Professor of Palaeontology and Historical Geology in Norway in 1909, and a few years later became Director of the University Palaeontological Museum. His work included several publications on Ordovician stratigraphy and palaeontology (e.g. Kiær 1901), but he is best known for his work on the Silurian (Kiær 1908) and early vertebrates. Olaf Holtedahl (1885-1975) became Professor of Historical Geology in 1920. Covering most aspects of geology, an early work of his (Holtedahl 1910) dealt with the Ordovician of the Mjøsa district where he worked out a local stratigraphy. He thus took into account Brøgger's early (1887) warning (forgotten by many subsequent workers) that the classification of Etage 4 on the islands near Oslo cannot be applied uncritically to other areas. A later paper by Holtedahl (1916) was on Ordovician and Silurian strophomenid

brachiopods of the Oslo Region.

The foundation in 1916 of the University Palaeontology Museum, installed shortly after in its present building, led to an increase in the number of palaeontologists. This was followed in 1935 by the establishment of an Institute of Palaeontology, first housed in the Museum at Tøyen but later incorporated in the reorganized Institute of Geology on the university campus at Blindern. The leader of the former institute was Leif Størmer (1905-1979), Professor in Historical Geology from 1946. Contributing numerous articles, especially on trilobites and merostomes, many of Størmer's papers are on Ordovician stratigraphy and palaeontology. Størmer was the founder of what has become known as the 'Middle Ordovician Project', carried out by a research team including foreign specialists. The background for the project, its stratigraphical starting-point and objectives were outlined by Størmer (1953) in the first of what has since become 30 contributions (see reference list), forming a magnificent monument to his memory.