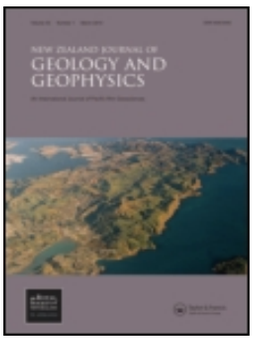

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ROCK-STRATIGRAPHIC NAMES FOR THE SOUTH ISLAND SCHISTS AND UNDIFFERENTIATED SEDIMENTS OF THE NEW ZEALAND GEOSYNCLINE

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Abstract

In the South Island the rocks deposited in the New Zealand Geosyncline of Late Paleozoic and Mesozoic age now form three main belts, non-schistose sediments lying both to the east and discontinuously to the west of a schist belt. For the non-schistose sediments of the eastern belt the name "Torlesse Group," derived from Haast's "Mount Torlesse Formation," which was used in a similar sense, is proposed. For the median schist belt the name "Haast Schist Group," named from the Haast River, is proposed, to embrace all the schistose rocks of the geosyncline.

INTRODUCTION

The greater part of the South Island consists of rocks deposited during a single geosynclinal phase, whose time of beginning is not clearly known but was probably in the Carboniferous or early Permian. Many of the rocks are now schists, but the times of sedimentation and of metamorphism of these rocks are far from certain. It is now commonly thought that the main axis of deposition of the "New Zealand Geosyncline" (Wellman, 1956) did not remain constant in position, and that tectonic movements within the geosyncline led to the cessation of deposition in it at different times in different places.

In the South Island the deposits of the New Zealand Geosyncline now form three main belts, non-schistose sediments lying both to the east and discontinuously to the west of a belt of schist. Fossils are fairly common in the western belt of sediments but are sparsely distributed in the eastern belt. Although they range in age from Permian to upper Jurassic, nowhere in the eastern belt has a sequence of fossils been described, and it is remarkable that few are known of ages between the restricted ages of the main fossil types—Permian (*Atomodesma*); mid-Triassic (Kaihikuan fauna); upper Triassic (*Monotis*); upper Jurassic (*Buchia*). *Terebellina,* probably little older than *Monotis,* is widely distributed. Although the decline of the influence of the New Zealand Geosycline is marked in Marlborough by upward transition in the Cretaceous from deeper-water (mainly redeposited) to shelf sediments, even the older Cretaceous sediments show some distinctions in lithologic characters that enable tentative sequences to be determined, commonly supported by sequences of fossils. In following these sequences stratigraphically downwards, however, there comes a point where no adequate distinction can be made from the bulk of the monotonous greywacke-dominated sediments deposited during the major geosynclinal phase. Although the degree of induration or metamorphism – the rank –

generally increases with age, rocks of similar rank vary in age, this being best shown by the Permian to upper Triassic ages of sediments in the transition zone between schistose and non-schistose rocks.

Wellman (1952) introduced names for sedimentary facies within the rocks of the Geosyncline. Based apparently on type of deformation, relative abundance of fossils, and thickness of beds, the names "Hokonui facies" and "Alpine facies" were evidently intended to epitomise different sedimentary enviroments within the geosyncline. In 1956 Wellman introduced "shelf facies", "transitional facies", and "redeposited facies" in the Permian parts of the sequences, stating that in the Mesozoic part "Hokonui" represented the shelf and transitional facies and "Alpine" the redeposited facies. Recognition of sedimentary facies is a step in interpretation but gives little help in making clear the stratigraphic units. Moreover only broad generalisations with respect to the geosynclinal environments are possible without interpretation of the schists in terms of their original sedimentary facies. It may well be that the contrasts in internal schist structures between the schists of Otago and of the northern Alps are due, in part at least, to differences in original lithology.

The use of "metamorphic facies" indicating grades of metamorphism raises possibilities of confusion with the sedimentary facies, particularly as recently Coombs *et al.* (1959) introduced into New Zealand the term "zeolite facies" for rocks of a grade that includes most of the Permian-Jurassic sediments of "Alpine" or "redeposited" sedimentary facies. The schists fall within the greenschist and amphibolite metamorphic facies, biotite and chlorite zones being separately distinguished in the greenschist facies.* The chlorite zone itself has been subdivided into subzones on the basis of the degree of internal reconstitution and texture. The lowest-rank subzone, chlorite subzone 1, is almost impossible to distinguish on field criteria; the rocks show no schistosity, but the early stages of internal reconstitution within the chlorite zone can be recognised under the microscope. They are transitional between rocks that show neither microscopic nor macroscopic characters of chlorite zone rocks and those showing incipient schistosity (semi-schists).

This paper is concerned with the schist and with the eastern belt of sediments. The sediments were described as "Undifferentiated Jurassic-Triassic-Permian" rocks on the 1 : 1,031,760 New Zealand Geological Survey map (1947) and in the appropriate section (Willett, 1948) of the accompanying booklet. On the 1 : 2,000,000 New Zealand Geological Map (1958) and in the accompanying bulletin (Grindley *et al.*, 1959), they were described as "Undifferentiated greywackes", being distinguished by symbols indicating the age range. Both these maps covered the whole of New Zealand, and an age basis dominated the legends.

Although the present paper is concerned with the South Island, analogous problems of naming rock units arise also in the North Island; indeed it can be maintained that the broad similarities of sequences in the two islands should be emphasised by the use of rock-unit names common to both. This is for the future, however; the present need is for agreement on a satisfactory

*More recently Coombs (1960) has introduced a "prehnite-pumpellyite metagreywacke facies" that covers some rocks of chlorite subzones 1 and 2 as well as less metamorphosed rocks of higher rank than the zeolite facies.

nomenclature for the practical problems that arise where the schists and "undifferentiated" sediments of the New Zealand Geosyncline extend continuously through several of the map sheets of the 1 : 250,000 series at present in preparation by the New Zealand Geological Survey. The greater part of the South Island forms the major region where these problems arise.

1 : 250,000 MAPPING OF "UNDIFFERENTIATED" SEDIMENTS

The New Zealand Geological Survey's present 1 : 250,000 mapping programme allows greater flexibility in the legends than in recent smaller-scale maps. The first map in the new series to show the "undifferentiated" sediments was Sheet 21, Christchurch (Oborn and Suggate, 1959). A tiny area in Banks Peninsula was shown as undifferentiated Gore-Kawhia Series; a small area in the Canterbury foothills was shown as Balfour Series, because of the presence of *Terebellina*. This mapping followed the procedure of mapping in ages which is being used throughout the series of maps. The North Island Sheet 4, Hamilton (Kear, 1960) illustrates the compromise necessary where both "differentiated" and "undifferentiated" beds of comparable ages are mapped. Whereas time-stratigraphic stage subdivision of fossiliferous Kawhia Series beds was possible in the west, only "undifferentiated" Kawhia Series could be shown to the east, poorly fossiliferous beds of this age being described as Manaia Hill Group. In Sheet 2B, Barrier (Thompson, 1960) the age of the greywacke and argillite is so poorly known that its age range is given as (?)Maitai to Kawhia; it is described under Moehau Formation. Rock-stratigraphic names for the "undifferentiated" greywacke are also used on some at least of the other North Island 1 : 250,000 sheets, for example Sheet 8, Taupo.

In the South Island two main features require to be indicated: the presence of fossils of widely different ages, and the apparent continuity of the greater part of the "undifferentiated" rocks.

The continuity of the "undifferentiated" beds as a whole, their monotony, and the lack of known stratigraphic breaks, require to be immediately emphasised. The beds form a single rock-stratigraphic unit, and should be appropriately named. To show within individual sheets only a series of isolated areas, with their age or age range, and to omit any unifying rock-unit name would give a false impression of the stratigraphy.

1 : 250,000 MAPPING OF THE BOUNDARY BETWEEN SCHISTS AND "UNDIFFERENTIATED" SEDIMENTS

The boundary between chlorite subzones 1 and 2, roughly coincident with the change from non-schistose to semi-schistose greywackes, has been adopted as the mapping boundary between two major units. The essentially transitional character of the change makes the boundary—in common with all boundaries between rock units that grade into each other—arbitrarily defined at most places. Both microscopically and macroscopically, the most satisfactory type of rock for judging the degree of metamorphism is greywacke; argillite and volcanic rocks tend to show schistosity earlier than greywacke; greywacke that shows incipient schistosity falls within chlorite subzone 2 and is mapped as schist.

The chosen boundary between schists and "undifferentiated" sediments is reasonably satisfactory for field mapping, and accordingly forms a suitable boundary between named rock-stratigraphic units. If individual formations or members within the "undifferentiated" sediments could be traced continuously into the schists, rock units transgressing metamorphic boundaries would be needed. No such units have been recognised, and it is necessary to adopt units on the existing criteria.

1 : 250,000 MAPPING OF THE SCHISTS

The schists are to be mapped in terms of metamorphic zones and subzones. The only distinct rock-stratigraphic units recognised within them are belts of metamorphosed volcanic rocks, and these will be separately distinguished within the metamorphic zone into which they fall. Although recent mapping has revealed complex internal structures in the schists, no units suitable for mapping purposes have been described, and the metamorphic zoning provides the best subdivision at present.

The important considerations for naming the schists are in part similar to and in part different from those for naming the "undifferentiated" sediments. Regional differences in texture and internal structure in the schists can be more clearly distinguished than regional differences in lithology within the "undifferentiated" sediments, so that the modern regional names, especially "Otago" and "Alpine", which perhaps over-emphasise the differences, have more in common with sedimentary-facies names than with formation names. As a group of rocks, the schists have a unity imposed by their metamorphism. The schists of Otago and the Alpine regions grade into each other and no satisfactory boundary can be drawn. The schists of Marlborough are separated on an areal basis but have no specific characteristics that distinguish them. There is no doubt that when Harrington (1959, pp. 289–91) attributed "Otago Schist" to Benson (1921), and when Reed (1959a, pp. 18–9, and 1959b, pp. 223–4) attributed "Alpine Schist" to Wellman (1952) and "Marlborough Schist" to King (1939), they formalised, without defining, terms that were never intended to be other than informal and undefined. Benson clearly intended to refer only to the schist of the Otago region, and Wellman and King merely used the names Alpine and Marlborough respectively in map legends.

Yet, just as with the sediments, a single name is desirable by which to refer to the schists—as is clear from the use of "Otago, Alpine, and Marlborough Schists", for example, on the New Zealand Geological Survey's 1 : 2,000,000 map (1957) and in the accompanying bulletin (Grindley *et al.*, 1959). It is accordingly held desirable to use a single name for the schists as a whole, and to allow the recently-used regional names to lapse into a useful informal usage—for example, "Otago schists" as the schists of the Otago region—until such time as they are formally defined.

A ROCK-STRATIGRAPHIC NAME FOR THE "UNDIFFERENTIATED" SEDIMENTS

No attempt will be made to review fully the original definition and subsequent usage of names that have been used for parts, large or small, of the "undifferentiated" sediments. This has been done by various authors

in the *International Stratigraphic Lexicon,* Volume 6, Fascicule 4, "New Zealand"; but it is advisable to refer also to the original authors.

The following names have been used:

Mount Torlesse; 1865 ..	Embraces all the "undifferentiated" sediments of the Southern Alps and Canterbury foothills in the usage of Haast, who originally proposed it.
Maitai; 1873	First extended from the type area east of Nelson to cover some "undifferentiated" sediments of Canterbury by Hector, but even then probably in a time-stratigraphic rather than a rock-stratigraphic sense. It is doubtful whether there has been any rock-stratigraphic usage of Maitai for "undifferentiated" sediments during this century.
Kaikoura; 1874 ..	Used by Hutton in the north-east of the South Island, except for eastern areas (probably mainly Jurassic) that he mapped as "Maitai" and younger.
Mount Potts; 1874 ..	Applied by Haast to a section in the Mount Potts area, fossiliferous at two localities; or (Hector) restricted to the fossiliferous beds.
Wharfdale; 1884 ..	Local name given by Hector to one particular formation.
Hokonui; 1885.. ..	Originally used by Hutton in a time-stratigraphic sense, the best known fossiliferous sequence at the time being in Southland. It has not been used in a rock-stratigraphic sense for the "undifferentiated" sediments. Since 1951 its use has been entirely time-stratigraphic (System), except that it was applied by Wellman (1952) to a sedimentary facies that specifically excludes the "undifferentiated" sediments.
Clyde River; 1904 ..	Proposed by Park for a particular section north-west of Mt Potts. Later he abandoned it for "Aorangi".
Mount St Mary; 1904 ..	Name introduced by Park for a sequence at Mount St Mary, fossiliferous in part.
Aorangi; 1910 ..	Apparently restricted by Park to pre-Kaihikuan beds, within the Hokonui System.
Ida; 1933	Local name applied in Ida Range by Williamson.
Waihemo; 1934 ..	Local name applied in Kakanui Ranges by Williamson.
Mount Robert; 1935 ..	Local name of Fyfe, including (?) some semi-schists.

Haast's "Mount Torlesse Series" (later "Formation") was used by him to embrace all the beds in the South Island that have recently been called "Undifferentiated Permian-Jurassic" rocks. Its age range and subdivision were argued, somewhat acrimoniously, by Hector (1885) and Haast (1885). Haast maintained that there was a single formation, although he conceded that there might be a considerable range of ages; Hector maintained that there was enough fossil evidence to substantiate a considerable age range so that subdivision was justified. The present position is that the greater amount of fossil evidence now available gives an improved knowledge of the distribution of rocks of different ages, but that boundaries and relationships are not yet established. Indeed these will be established only by mapping in formations within the major unit that Haast recognised.

It may be contended that the name "Mount Torlesse" is too closely associated with the occurrence of the annelid *Terebellina,* formerly *Torlessia,* which is thought to be restricted in its age range. The association is largely through Hector's use of "Mount Torlesse" as a locality prefix to "annelid beds". Although "Mount Torlesse Annelid Beds" is listed by Adkin (1954) as a stratigraphic name, which has been perpetuated in the *International Stratigraphic Lexicon* (Grindley, 1959a, p. 254), this can scarcely be supported by referring to the three usages listed by Adkin. The

first (Hector, 1886, p. xxx) appears to equate the particular annelid beds, located at Mount Torlesse, with Haast's Mount Torlesse Formation, which is not in keeping with Haast's own usage. The other two are locality names in fossil lists.

It is recommended that Haast's name be retained, but that "Mount" be omitted. Gordon (1890) used "Torlesse Slates" on a map legend for the "undifferentiated" sediments of the Mount Cook area, an area shown by Haast (1879) as Mount Torlesse Formation. There appears no justification for Grindley's (1959b, p. 409) equating Gordon's "Torlesse Slates" with the supposed formation "Mount Torlesse Annelid Beds" that he attributed to Hector.

The status of the unit is considered to be that of a Group, embracing the individual formations that are listed above, as well as all the remaining "undifferentiated Permian-Jurassic" rocks of the South Island east of the schist belt. Thus Haast's original usage is reinstated, the name being modified to "Torlesse Group".

In Marlborough the upper limit of the Torlesse Group is not everywhere easy to define. At Seymour Stream (Suggate, 1958) south of Trig. GZ, Jurassic (? basal Cretaceous) siltstone and indurated sandstone with "cannon-ball" concretions, which is unconformably overlain by the Split Rock Formation of Motuan age, is here assigned to the Torlesse Group. But elsewhere, as for example in the Coverham area (Wellman, 1955, p. 110), the apparent transition from "undifferentiated" greywacke and argillite to "Clarentian" beds prevents easy definition. It will be necessary to define formations carefully and decide whether they are best included in the upper part of the Torlesse Group or whether they should stand apart.

It has been noted above that the end of geosynclinal deposition differed in time from place to place, and the succeeding formations are not of uniform age. The oldest succeeding formations—the Cairn Range (= Malvern Hills = Wakaepa) and Clent Hills Formations—comprise sandstones, conglomerates, and shales containing floras of middle or upper Jurassic age (Edwards, 1934) that are inferred to rest unconformably (Speight, 1928, p. 8; 1938, p. 15) on greywacke here included in the Torlesse Group.

A NAME FOR THE SCHISTS OF OTAGO, THE SOUTHERN ALPS, AND MARLBOROUGH

The following list includes most of the names given to schists, with brief comments. Fuller descriptions are given by various authors in the *International Stratigraphic Lexicon*, Volume 6, Fascicule 4, "New Zealand" (1959), in which the original references are listed.

There are three main groups of names. The first (e.g., Lake Harris, Kurow, Glenroy) are names essentially used for local mapping, and only occasionally used beyond their original localities. Names of the second group (e.g., Maniototo, Kakanui) have been extended from local usage on a rank basis. Those of the third group (Otago, Marlborough, and Alpine) are modern regional names unrelated to rank.

Kakanui; 1865	Generally restricted to schists of chlorite subzones 2 and 3.
Tuamarina; 1874	Chlorite zone schists only, because higher rank schists are not present.
Wanaka; 1875	Generally restricted to coarsely-foliated chlorite zone schist.
Waihao; 1879	Schists of chlorite subzones 2 and 3, mapped by Haast as distinct from gneiss-granite (chlorite subzone 4, biotite and garnet zones); but not consistently mapped.
Lake Harris; 1881	Chlorite zone schists.
Cecil and Walter Peak; 1881 ..	Low-rank chlorite zone schists.
Kurow; 1882	Schists of chlorite subzones 2 and 3.
Maniototo; 1906	Foliated chlorite zone schists, but extended to some metamorphic rocks of Nelson and Fiordland.
Awamoko; 1918	Almost synonymous with "Kakanui".
Glenroy; 1935	Schists of chlorite subzones 2 (?) and 3, biotite and garnet zones.
Otago; 1959 Marlborough; 1959 Alpine; 1959 ..	Formalised without definition, in 1959, as regional names, based on earlier informal usages. Validity based presumably on undefined differences in character.

With the introduction of rank subdivision into zones and subzones over 20 years ago, the named rank-implying formations have been rendered too imprecise for retention. The regional names are unsuitable for application to all the schists because they have been used for purposes of contrast. The local names cannot be satisfactorily extended because the localities are clearly situated in one region or another, and because they are associated with only parts of the metamorphic range.

A new name is required to embrace all the schists produced by regional metamorphism of the rocks of the late Paleozoic – Mesozoic geosyncline and a name from an area not closely associated with the regional names is perhaps desirable. The name "Haast Schist Group" is therefore proposed. Approximately at the junction of the Alpine and Otago areas, the schists of the Haast River catchment embrace all the schist zones (Turner, 1933). Turner's recognition of oligoclase zone rocks to the west as well as to the east of the Alpine Fault does not detract from the value of the Haast section. The Haast Schist Group is intended to embrace all the schist formations listed above.

REFERENCES

ADKIN, G. L. 1954: Bibliographic Index of New Zealand Stratigraphic Names. *N.Z. geol. Surv. Mem. 9.*

BENSON, W. N. 1921: Recent Advances in New Zealand Geology. *Rep. A'asian. Ass. Adv. Sci. 15*: 45–133.

COOMBS, D. S., 1960: Lower Grade Mineral Facies in New Zealand. *Rep. int. geol. Congr. 21 (13)*: 339–351.

COOMBS, D. S.; ELLIS, A. J.; FYFE, W. F.; TAYLOR, A. M. 1959: The Zeolite Facies, with Comments on the Interpretation of Hydrothermal Syntheses. *Geochim. Cosmoch. Acta 17*: 53–107.

EDWARDS, W. N. 1934: Jurassic Plants from New Zealand. *Ann. Mag. Nat. Hist., Ser. 10, 13*: 81–109.

GORDON, H. A., 1890: Explorations, South Westland. *Append. J. House Repres. N.Z., C.–3*: 96–7.

GRINDLEY, G. W. 1959a: Mount Torlesse Annelid Beds. *Lex. stratig. int. 6 (4)*: 254.

GRINDLEY, G. W. 1959b: Torlesse Slates. *Lex. stratig. int. 6 (4)*: 409.

GRINDLEY, G. W.; HARRINGTON, H. J.; WOOD, B. L. 1959: The Geological Map of New Zealand. *N.Z. geol. Surv. Bull. n.s. 66.*

HAAST, J. 1879: "Geology of the Provinces of Canterbury and Westland, New Zealand," "Times" Office, Christchurch.

HAAST, J. 1885: On the Geological Structure of the Southern Alps of New Zealand, in the Provincial Districts of Canterbury and Westland. *Trans. N.Z. Inst. 17*: 332–337.

HARRINGTON, H. J. 1959: Otago Schist. *Lex. stratig. int. 6 (4)*: 289–91.

HECTOR, J. 1885: Note on the Geology of the Canterbury Mountains. *Trans. N.Z. Inst. 17*: 337–340.

HECTOR, J. 1886: Progress Report, 1885. *N.Z. geol. Surv. Rep. geol. Explor. 1885, 17*: ix–xl.

KEAR, D. 1960: Sheet 4, Hamilton. Geological Map of New Zealand 1 : 250,000. Dep. Sci. Industr. Res., Wellington.

KING, L. C. 1939: The Relation between the Major Islands of New Zealand. *Trans. roy. Soc. N.Z. 68*: 544–569.

OBORN, L. E.; SUGGATE, R. P. 1959: Sheet 21, Christchurch. Geological Map of New Zealand 1 : 250,000. Dep. Sci. Industr. Res., Wellington.

REED, J. J. 1959a: Alpine Schist. *Lex. stratig. int. 6 (4)*: 18–19.

REED, J. J. 1959b: Marlborough Schist. *Lex. stratig. int. 6 (4)*: 223–224.

SPEIGHT, R. 1928: The Geology of the Malvern Hills, *N.Z. Dep. sci. industr. Res. geol. Mem. 1.*

SPEIGHT, R. 1938: The Geology of the Mount Somers District. *N.Z. Dep. sci. industr. Res. geol. Mem. 3.*

SUGGATE, R. P. 1958: The Geology of the Clarence Valley from Gore Stream to Bluff Hill. *Trans. roy. Soc. N.Z. 85*: 397–408.

THOMPSON, B. N. 1960: Sheet 2B, Barrier. Geological Map of New Zealand 1 : 250,000. Dep. Sci. Industr. Res., Wellington.

TURNER, F. J. 1933: The Metamorphic and Intrusive Rocks of Southern Westland. *Trans. N.Z. Inst. 63*: 178–284.

WELLMAN, H. W. 1952: The Permian-Jurassic Stratified Rocks. *Symposium sur le Séries de Gondwana, 19th Int. geol. Congr.*: pp. 13–24.

WELLMAN, H. W. 1955: A Revision of the Type Clarentian Section at Coverham, Clarence Valley, S35. *Trans. roy. Soc. N.Z. 83*: 93–118.

WELLMAN, H. W. 1956: Structural Outline of New Zealand. *N.Z. Dep. sci. industr. Res. Bull. 121.*

WILLETT, R. W. 1948: Undifferentiated Jurassic-Triassic-Permian. *In* "The Outline of the Geology of New Zealand." N.Z. Geological Survey, Wellington.