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CORRELATION CHART OF CAMBRIAN AND ORDOVICIAN IN AUSTRALIA

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CONTENTS

INTRODUCTION

The present Correlation Chart summarizes the published information concerning the stratigraphy of the Cambrian and Ordovician of Australia as outlined in the "Notes" at the end of this record. The Chart is incomplete, but it can be amplified concurrently with the publication of new information from the field. The main part of the chart is its "Time-Scale", which also is subject to improvement and amplification. The main objective of forthcoming studies is a more detailed subdivision of the upper two-thirds of the Upper Cambrian and of the Ordovician. But even now the scale is fully applicable for correlation of the deposits of central Australia (MacDonnell Ranges to western Toko Range region), as seen from fossil collections and field studies.

The author has had the opportunity to communicate orally to his colleagues his ideas concerning the meaning, principles, and methods of geological correlation. These ideas are now summarized to give a brief outline of the philosophical background to the present Chart.

MEANING OF CORRELATION

Geological or time correlation

Geological correlation as reflected in the present Chart is a presentation of the distribution in time of formations and intervening breaks. The ultimate goal of geological correlation is the discovery of contemporaneous geological events as recorded in rocks. These events are deposition, as recorded by the formations, and erosion, deformation, and uplift, as recorded in the breaks. Time relationship alone is studied and presented, and causality, interdependence of events, reciprocity, and any other "true correlation" are not considered at all.

Established or estimated time relationships may, however, provide clues for the discovery of "true correlation" as well. For example, uplift and erosion in the provenance areas on the one hand, and deposition of waste on the other, are concurrent events; but they may also be interrelated causally and therefore represent "true correlates". Of course, contemporaneity alone is not evidence that particular breaks and formations are such correlates.

These brief remarks indicate that "correlation" has a dual meaning. For this reason terms like "geological correlation" or "time-correlation" should be used to designate pure time relationship, and the term "correlate" (the noun) should not be used at all except in its correct lexical sense.

Objects of time-correlation

Time-correlation operates with diverse objects. In the following reasoning, for the sake of simplicity, the particular case of diverse formations only is considered. So, diverse formations are recognized in the Chart by their diverse names and are arranged to demonstrate their distribution in time. Repetition of one and the same formation name in several columns is not correlation because this repetition is not an indication of diversity, but a certificate of integrity; and single, integrate, objects cannot be correlated with themselves. Of course, time-correlation can be applied between geographically separate and spatially discontinuous members of a formation, because the idea of diversity can be applied to them.

"Extension of usage" of a formation name "by correlation" cannot be accepted: when the term correlation (time and/or true correlation) is used, it is a statement of the existence of at least two diverse rock-units which should have different names.

Means of correlation

Means and methods of time-correlation have been repeatedly discussed during the past century. Intuition, artistry, and science have been applied, and a review of the methods is unnecessary in the present brief notes. All means and methods are acceptable that lead to a result correct within limits, being based on observable facts. The following discussion is restricted to the fundamental principles of time-correlation.

A formation is correlated when its position in a time scale is established; all formations or parts of formations in the same chart position are also "mutually correlated". Two or more formations (diverse rock-units) are mutually correlated when identical time-markers are discovered in these formations, even if these time-markers cannot be referred to a position in a time-scale, as, for example, when a time-scale is not available. So, the principles of time-correlation can be summarized as follows: (1) two or more diverse formations are the objects of correlation; (2) within these diverse entities, identical time-markers should be present.

Fossils are the supreme and the only reliable time-markers. Most reliable are identical species, whereas genera and assemblages of genera are less reliable and introduce wider limits of uncertainty. The "resolving power" of fossils has limits within which the answer will remain uncertain.

Just as a thermometer gives only its own temperature, which is used for reasonable extrapolation, so a fossil determines its own age, and so does a "fossil band". An extrapolation up or down from them becomes rapidly uncertain and is a major source of error. Intrapolation between two fossil horizons is, however, safe and has been applied wherever possible in the present Chart.

For the purpose of the Chart the lowermost and the uppermost fossils in a section and in each formation were most rewarding. Of course, most of the correlated formations are fossiliferous in general.

Superposition is an important aid in correlation: a break or an unfossiliferous sequence (formation) is correlated when the correlation of beds above and below is known.

Kinds of correlation

Three kinds of time-correlation can be listed here:

1. Correlation between two or more formations without reference to a particular time-scale. This is usually of areal, local, or sub-regional significance. When a scale is not available extrapolation over wider geographical regions rapidly becomes uncertain.

2. Correlation by reference to a time-scale (the safest kind); it is of regional significance and its accuracy depends on the fossil record of the formation and the accuracy of the scale.

3. Correlation between diverse regional scales, which is of interregional and intercontinental significance.

It should be understood that even within a single region several diverse scales may have validity and are useful. They should be correlated mutually.

The present Chart is based on kind 2, but to construct the scale the other kinds (1 and 3) were applied. The present scale leads to correlation with the Scandinavian, American, and Asian scales (Öpik, in press).

"Correlation" by similarity of lithology may be only a statement of integrity (disrupted continuity, identity), or a guessed time correlation. This "correlation" is as uncertain as a statement of contemporaneity by reason of dissimilarity of lithologies. In the absence of fossils other geological evidence (superposition, matching of sections, palaeogeography, unique marker beds in otherwise different sequences, etc.) should be considered, but even then the limits of uncertainty will remain very wide.

NOTES ON THE CHART

1. The Chart is compiled from, and supplements, published material. The sources are the Australian Section of the Cambrian Symposium (Öpik et al., 1957) and a forthcoming paper on the Cambrian and Ordovician geology of Queensland (Öpik, in press). These papers serve as exhaustive "explanatory notes", giving reasons for correlation, including overseas correlation, and locality maps.

2. The following regions are not included: South Australia, which refers mainly to Lower Cambrian; Tasmania, whose correlation is already published (Öpik et al., 1957); central Australia (MacDonnell Ranges to western Toko Range), because of the absence of published modern material, which is forthcoming.

3. Correlation of the Victorian sequence is presented according to Öpik (1956/57) and is at variance with Thomas & Singleton (1956/57). The columns for Cambridge Gulf, Ragged Range, and Negri are at variance with the correlation proposed by Traves (1956/57).

4. Ordovician is included, first, for its own sake, and, secondly, because of its lithological continuity with the Upper Cambrian. Reliable datum faunas have not yet been identified for the top of the Cambrian, nor for the base of the Ordovician.

5. "Pilpah Ra." in the Chart should read "Ogilvie Ra." (see Mt. Isa 4-mile sheet).

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THOMAS, D.E., & SINGLETON, O.P., 1956/57 - The Cambrian stratigraphy of Victoria. CAMBRIAN SYMPOSIUM, part 2, p.149.

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TIME SCALE	
ORDOVICIAN	LLANVIRNIAN ARENIGIAN TREMADOCIAN
UPPER CAMBRIAN	TREMPEALEAUAN FRANCONIAN DRESBACHIAN
MIDDLE CAMBRIAN	*LAEVIGATA III* *LAEVIGATA II* *LAEVIGATA I* *NATHORSTI* *PUNCTUOSUS-NATHORSTI* *PUNCTUOSUS* *PARVIFRONS* *ATAVUS* *ATAVUS GIBBUS* *GIBBUS* *XYSTRIDURA* *REDLICHIA*
LOWER CAMBRIAN	
PRECAMBRIAN	

Locality	Succession (top to bottom)
BORDER W.H.	UNCONFORM.1 LANCEWOOD CURRANT B. BORDER W.H. DISCONFORM. CAMOOWEAL UNCONFORM. 6 CONSTANCE
SEYMOUR R.	BEETLE CK. at Lawn Hill THORNTONIA "Girvanella puddings" UNCONFORM.6 BASEMENT
UNDILLA BASIN	UNCONFORM.1 PROBABLY ERODED SPLIT ROCK MAIL CHANGE V - CREEK AGE CK. CURRANT BUSH INCA THORNTONIA BEETLE CK. "YELVERTOFT" DISCONFORM. UNNAMED DISCONFORM. CAMOOWEAL UNCONFORM.6 BASEMENT
WHISTLERS CK.	UNCONFORM. 1 SPLIT ROCK MAIL CHANGE V - CREEK INCA BEETLE CK. "YELVERTOFT" DISCONFORM. CONGLOMERATE UNCONFORM. 6 PILPAH
PILPAH RA.	SPLIT ROCK DISCONFORM. BEETLE CREEK "YELVERTOFT" UNCONFORM. 6 PILPAH
BEETLE CK.	UNCONFORM. 1 INCA BEETLE CK. "YELVERTOFT" DISCONFORM. UNNAMED UNCONFORM. 6 BASEMENT
MT. MERLIN	UNCONFORM. 1 SWIFT UNCONFORM. 2 NINMAROO DISCONFORM. 3 CHATSWORTH UNCONFORM. INCA DISCONFORM. BEETLE CK. DISCONFORM. THORNTONIA UNCONFORM. 5 MT. BIRNIE UNCONFORM. 6 BASEMENT
SELWYN RA	UNCONFORM. 1 O'HARA SELWYN RA DEVONCOURT ROARING DISCONFORM. 4 UNCONFORM. 5 MT. BIRNIE UNCONFORM 6 BASEMENT
POMEGRANATE CK.	CHATSWORTH O'HARA POMEGRANATE DEVONCOURT
BOULIA inc. De Little Ra.	UNCONFORM. 1 SWIFT UNCONFORM. 2 NINMAROO "GOLA" CHATSWORTH ? O'HARA POMEGRANATE MIDDLE CAMBRIAN PROBABLY COMPLETE
URANDANGI	NINMAROO DISCONFORM. CAMOOWEAL
QUITA CK.	UNCONFORM. 1 STEAMBOAT DIASTEM QUITA BLAZAN DISCONFORM. BEETLE CK. THORNTONIA UNCONFORM. 5 RIVERSDALE UNCONFORM. 6 BASEMENT
MUNGEREBAR	NINMAROO DISCONFORM. 3 MUNGEREBAR STEAMBOAT DISCONFORM BLAZAN DISCONFORM. "YELVERTOFT" UNCONFORM. 5 RIVERSDALE UNCONFORM. 6 BASEMENT
SYLVESTER CK.	GEORGINA NO OUTCROP "DEVONCOURT" DISCONFORM. 4 UNCONFORM. 5 SYLVESTER SUN HILL
SUN HILL	UNCONFORM. 1 NINMAROO DISCONFORM. 3 GEORGINA UNCONFORM. 5 SUN HILL
TYSON'S BORE	UNCONFORM. 1 NINMAROO DISCONFORM. 3 GEORGINA 1,800' OF SEDIMENTS BELOW GEORGINA
TOKO RA.	UNCONFORM. 1 TOKO UNCONFORM. 2 NINMAROO DISCONFORM. 3 GEORGINA "DEVONCOURT" in North-West UNCONFORM. 5 SUN HILL UNCONFORM. BOULDER-BEDS
CAMBRIDGE GULF	PANDER CLARK PRETLOVE SKEWTHORPE HART SPRING DISCONFORM. ANTRIM UNCONFORM. VICTORIA R.
RAGGED RA.	RAGGED RA. NEGRI DISCONFORM. ANTRIM UNCONFORM. VICTORIA R.
NEGRI	ELDER NEGRI DISCONFORM. ANTRIM VICTORIA R.
MT. LICHFIELD	ELLIOTT CK. (SALT BEDS SHALE LIMESTONE ARKOSE) UNCONFORM. GRANITE
DALY RIVER	DALY R. GROUP DISCONFORM. VOLCANICS UNCONFORM. TOLMER GROUP
TENNANT CK.	GUM RIDGE DISCONFORM. HELEN SPRINGS UNCONFORM. WARRAMUNGA
ALEXANDRIA	ALEXANDRIA UNCONFORM. SANDSTONE
RANKEN RIVER	PROBABLE DISCONFORM. RANKEN DISCONFORM. CAMOOWEAL UNCONFORM.
WONARAH	WONARAH UNCONFORM. BASEMENT
SANDOVER	SANDSTONE OUTLIERS DISCONFORM. SANDOVER UNCONFORM. 6 DAVENPORT
DOLODROOK	LANCEFIELDIAN UNCONFORM. 3 GARVEY GULLY DOLODROOK GARVEY GULLY MT. WELLINGTON
KNOWSLEY EAST	GOLDIE KNOWSLEY EAST DOLICHOMETOPUS BAND KNOWSLEY EAST DINESUS BAND KNOWSLEY EAST HEATHCOTE