BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD

RECORD 1988/10

EROMANGA - BRISBANE GEOSCIENCE TRANSECT: POSITION PAPERS PRESENTED IN FEBRUARY, 1988.

compiled by

D. M. Finlayson

RECORD 1988/10

EROMANGA - BRISBANE GEOSCIENCE TRANSECT:
POSITION PAPERS PRESENTED IN FEBRUARY, 1988.

compiled by

D. M. Finlayson

CONTENTS

Page

Introduction - D. M. Finlayson.............................. 1

The Global Geoscience Transects Project - J. W. H. Monger.... 2

Deep seismic reflection and refraction interpretations - D. M. Finlayson.............................. 8

Structure and tectonics of the Thomson Fold Belt - C. G. Murray...................................... 18

Gravity and magnetic interpretation - P. Wellman & R. J. Korsch...................................... 24

Palaeomagnetism - C. T. Klootwijk........................... 25

Geothermal Profiles - J. P. Cull & A. C. Cook................ 31

New England Orogen: structure and tectonics - R. J. Korsch, H. J. Harrington, C. L. Fergusson, P. C. Flood, J. Aitchison, & C. G. Murray............. 38

Clarence-Moreton Basin depositional and structural history - P. E. O'Brien & A. T. Wells........................ 44

Surat Basin and underlying basins - C. R. Fielding.......... 50

FIGURES

1. Deep seismic profiles, southern Queensland................ 16

2. Digitized reflectors along BMR Lines 1, 1X, 9, 14, 15, 17 and 16.. 17

3. Simplified regional geology................................ 23

4. Middle to Late Palaeozoic APWP for the Cowra Trough - Molong High according to Goleby (1980) and for Australia according to Schmidt et al., (1985)...................... 29

5. Alternative Middle to Late Palaeozoic APWP for Australia according to Klootwijk (1987, 1988)....................... 30

6. Heat flow values in the transect region.................. 35

7. Estimated heat flow, based on transformation of the geothermal gradient....................................... 36

8. Heat flow contours based on averages over 3^{o} grid....... 36

9. Depth vs reflectance profile for Yulcumma-1 well, southern Nappamerri Trough................................ 37

10. Definition of the Surat Basin region crossed by deep seismic reflection profile................................ 53

ABSTRACT

This Record contains information and ideas presented by participants in the Eromanga - Brisbane Geoscience Transect at the time of the 9th Australian Geological Congress in Brisbane during February 1988. The Record is designed as a working document to be used as a basis for further research and interpretations.

INTRODUCTION

As part of the Global Geoscience Transects Project of the Inter-Union Commission on the Lithosphere (ICL) a group of Australian geoscientists from various institutions is compiling information and interpretations along a transect from the central Eromanga Basin to the Beenleigh Block on the coast near Brisbane. The 1000 km route of the transect across southern Queensland approximately follows a deep seismic reflection profiling line completed by BMR during 1986. A major objective of the international project is to interpret geological and geophysical information jointly to identify the tectonic setting of the various geological features along the transect and try to identify tectonic kindred terranes elsewhere for international comparison. Interpretation should be based on information to at least the depth of the Moho.

From an Australian point of view, the southern Queensland transect is across a region with little basement outcrop yet great economic importance as an oil, gas and coal producing area. Geophysical techniques must, therefore, be used to understand more fully the tectonic evolution of the region.

This Record contains some of the initial information and ideas put forward by participants in the project and presented at the time of the 9th Australian Geological Congress in Brisbane during February 1988.

THE GLOBAL GEOSCIENCE TRANSECTS PROJECT

J. W. H. Monger
Geological Survey of Canada, Vancouver, Canada.

Introduction: In this note the nature and goals of the Global Geoscience Transects project (GGT) of the International Lithosphere Program (ILP)are described. The term transect refers to a cross-section drawn at least as deep as the Moho by synthesizing all available geological and geophysical information. A major objective is to ensure that data and interpretation are to be presented with enough commonality so that the nature of the crust in different parts of the world can be compared directly. Transect construction encourages regional and international cooperation between geoscientists of different disciplines, and identifies problems and knowledge gaps. It is hoped that preliminary drafts of transects will be displayed at the 28th International Geological Congress in Washington in 1989.

History of project: The project was conceived by the Inter-Union Commission on the Lithosphere in Tokyo in August, 1985 and is modelled on the North American continent:ocean transect program (see below). Subsequently, M. Barazangi of Cornell University was asked to prepare for discussion a map showing the possible global distribution of transects (Fig. 1). Although transect corridors shown on this map were drawn so as to

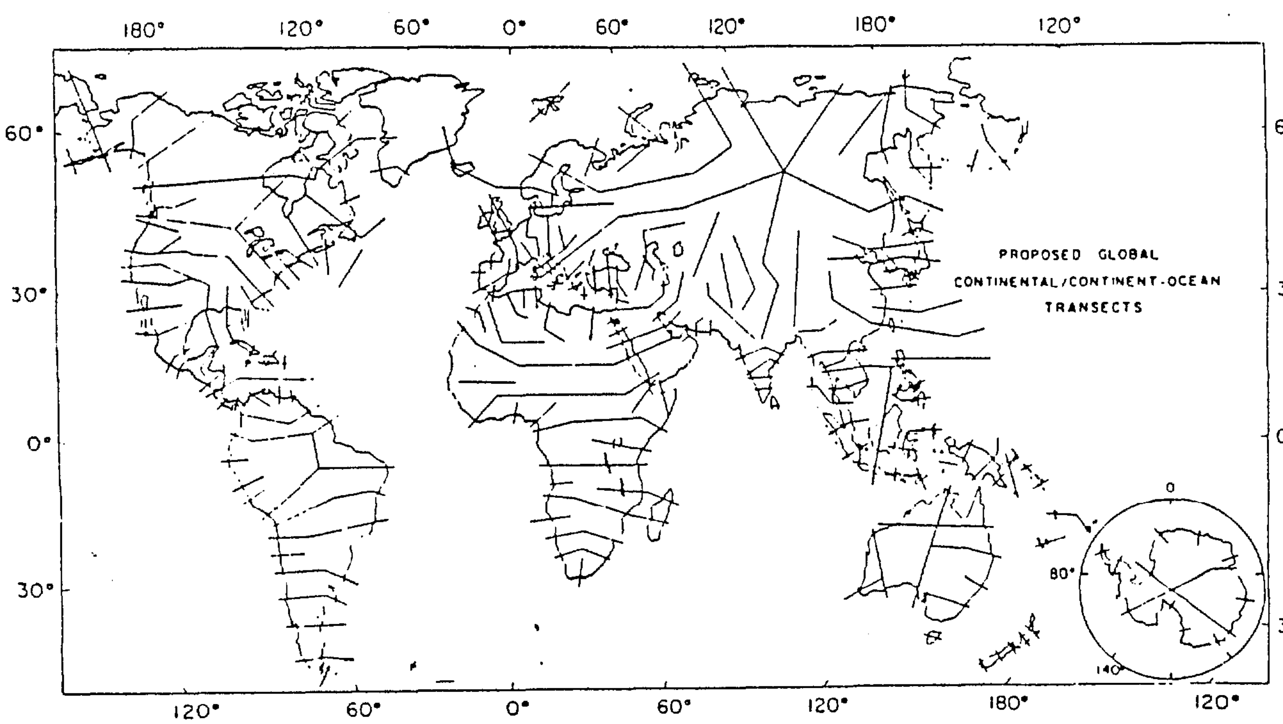


Figure 1: Possible distribution of transects (M. Barazangi).

take into account major geological structures and in some cases to follow previously implemented or proposed transects, in no way are they intended to dictate transect locations, which will be chosen by the regional compilers. However, the value of this map is that it gives a general idea of the global distribution and density of transects that GGT hopes to achieve, and also of the length of transects. Whereas the North American transects were restricted to the continental margins, transects evisaged for GGT extend across continents and marginal basin/intraoceanic arc regions. The Barazangi map served as a focus for discussion at a follow-up meeting on Global Transects, held in San Francisco in December 1985, and attended by representatives from North America, Europe and the developing countries. After this meeting, Professor Karl Fuchs, President of ILP, invited the writer to coordinate the project because of his experience in the North American transects program.

The nature of GGT: The transects lie along corridors selected by regional experts so as to cross and display major crustal features. The project is intended to synthesize the vast amount of geological and geophysical data available from surveys, made in most cases for other purposes. Their existence, quality and availability are best known to local and regional experts. Thus GGT is designed to involve scientists at the "grass-roots" level in a project of global scope. Much of the data recorded, for example, by national geological surveys, rarely finds its way directly into the international scientific literature or, if it does, is commonly reinterpreted by others. GGT is not intended to initiate new data-collecting programs, although it may do that indirectly by identifying gaps in knowledge or major problems.

A major function of GGT is to facilitate direct comparison of the crust and lithosphere in various parts of the world. Existing cross-sections of such major structural features as Phanerozoic mountain belts are scattered through various scientific journals and of a variety of scales. Typically, geological and geophysical cross-sections are shown independently of one another, or where combined in a single diagram are rarely integrated. Such integration is essential if we are to understand the evolution of the lithosphere. Although geophysics is the only practical means of "seeing" deeper parts of the lithosphere, it presents a picture of the present world; the record of lithospheric evolution can be extracted only from surface geology. Transect construction forces the integration of geological and geophysical data.

North American transects: The North American transects program was initiated in 1979 by the U.S. Geodynamics Committee, and R.C. Speed of Northwestern University was invited to be coordinator. It was designed to integrate the considerable amount of offshore seismic information with on-land geology and geophysics so as to show the structure and Phanerozoic evolution of marginal parts of the North American continent (Fig. 2). As of April, 1986, 10 out of 23 transects had been published by the Geological Society of America. To standardize presentation of data along the 23 transects a set of rules was worked out by considerable discussion and modified as transect drafting proceeded and problem areas identified. The rules attempt to clearly separate data from interpretation and demanded the following six mandatory entries:

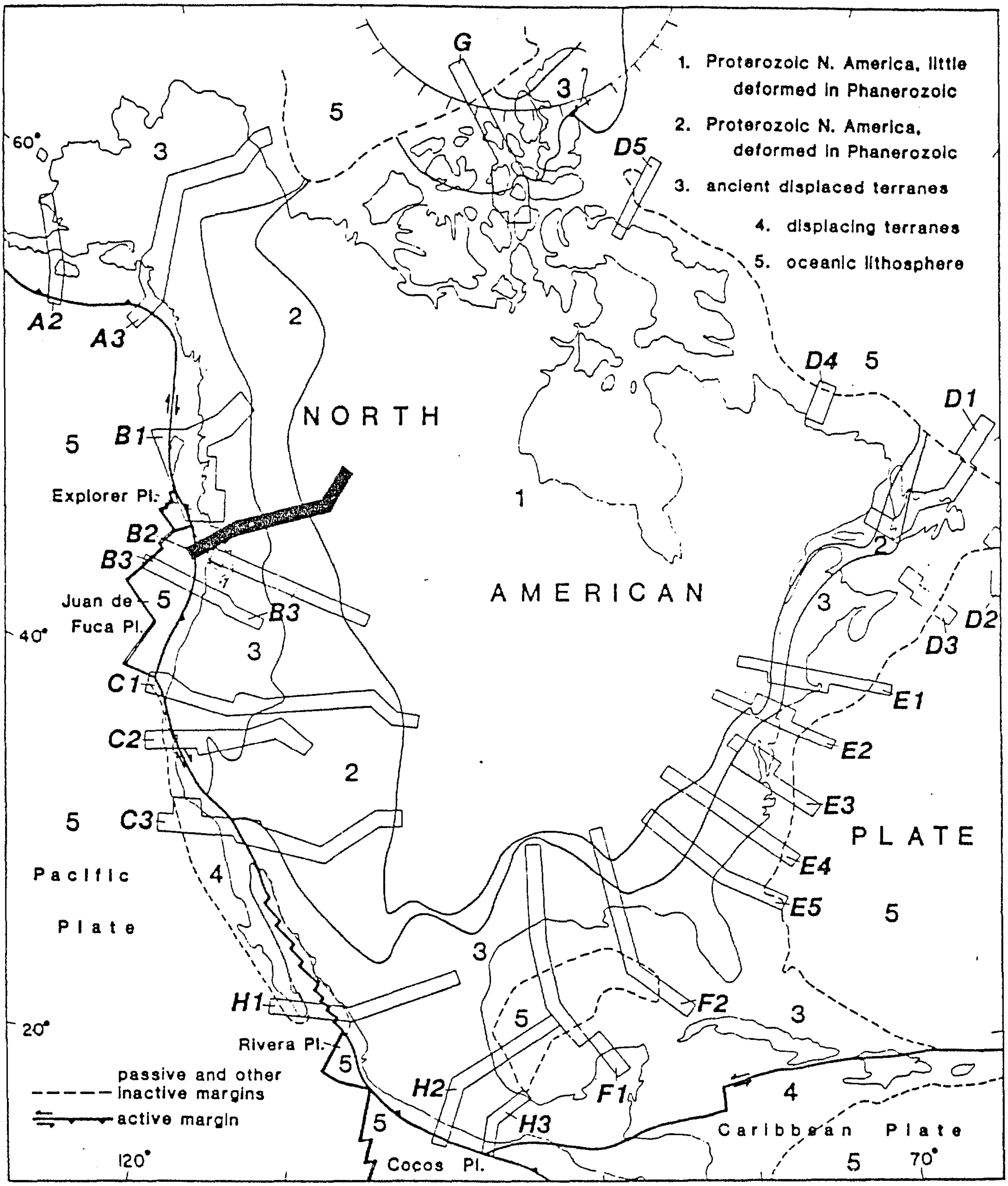


Figure 2: Distribution of transects on the Geological Society of America North American continent:ocean transect program. Note these are continental margin transects, in contrast to those proposed for GGT. The black transect, B2, is discussed below.

(1) A strip map of the 100 km wide transect corridor at the preferred scale of 1:500,000 (1:10^6 permitted) to show the geological setting of the cross-section line. The geographic

information on the map had to include latitudes and longitudes, main rivers and lakes, highways and railroads, and important settlements but otherwise was optional. Geological units on the map were to be color coded according to age, and to carry lithological symbols, and major structural features were to be shown.

(2) A geological cross-section was to be color coded according to age of geological units, and to be of scale 1:500,000, vertical = horizontal for on-land parts, although an expanded vertical scale was permitted for offshore sections. It was found that this scale allowed details of geological structure to be shown with reasonable detail, whereas a smaller size, say 1:10^6, permitted little more than a cartoon. The depth of the section was optional but most geologists were willing to project structures only to depths of 5-10 km. Geophysical data, such as reflectors, velocities, hypocentres, were to be displayed on or near this "factual" section.

(3) Geophysical profile data, were to include gravity (complete Bouguer on land and free-air at sea) and magnetic profiles.

(4) An interpretative cross-section scale 1:500,000, vertical = horizontal, was to show units coloured according to tectonic kindred (that is, the interpreted tectonic setting within which the rock unit formed), and lettered according to age range. This section was the transect proper, and represents an attempt to integrate geological, geochemical and geophysical data so as to produce a cross-section extending in depth at least to the Moho. This synthesis could be conservative, and merely show a generalized lower crust, or very interpretative and project surface structures and rock units downwards so as to build up the entire crust.

(5) A tectonostratigraphic event diagram, or time-space diagram, was to show the temporal evolution of the crust depicted by the transect.

(6) Various index maps and legends were necessary to accompany the above.

The suggested layout for these items was, from top to bottom, geological cross-section, strip map, interpretative cross-section, geophysical profiles and tectonostratigraphic diagram and legends, although in practice several alternative layouts were adopted.

Although adopted in principle by GGT, it seems likely that this scheme will need to be modified in detail for displays from different parts of the world. Two obvious modifications concern age color coding, and scale in certain circumstances. The North American transects deal mainly with Phanerozoic features, and so Precambrian rocks were denoted by different shades of one color, whereas GGT will cover extensive Precambrian regions. Similarly, by contrast with most North American transects, some proposed transects span wide regions of platformal cover beneath which details of basement structure are poorly known; in such cases a scale of 1:10^6 will be sufficient for displays. Other problems, such as the use of bases for corridor maps that may be drawn on different projections, and the depiction of the earth's curvature on long transects, will also have to be addressed. The writer would welcome comments and suggestions on these matters.

<u>Experience of the writer in transect construction:</u> Construction of the southern Canadian Cordilleran transect used a data base comprising complete 1:250,000 scale geological map coverage, local detailed maps, complete gravity and sea/airborne magnetic coverage, a seismic refraction profile compiled by R.M.Clowes, University of British Columbia from data of various ages and quality (Monger et al., 1985). At the time of drafting, the only available seismic reflection data were old oil company lines at the eastern end of the transect, and newer offshore lines, west of Vancouver Island.

A major problem was how to fill in the gap between the 5-10 km deep geological section provided by geologists, and the 20-55 km depth to Moho. This was done by using a model which proposes that the present geometry of the Cordillera is largely due to the accretion of "suspect terranes" of intraoceanic orgin which presently make up about two thirds of the width of the Canadian Cordillera (Monger et al, 1982). At the time of drafting this model seemed reasonable. Along the transect line, Moho depth varies in three steps: 45-55 km beneath the plains and the easternmost part of the Cordillera; 30-35 km beneath the central part; and 25-20 km under Vancouver Island in the west (Fig. 3).

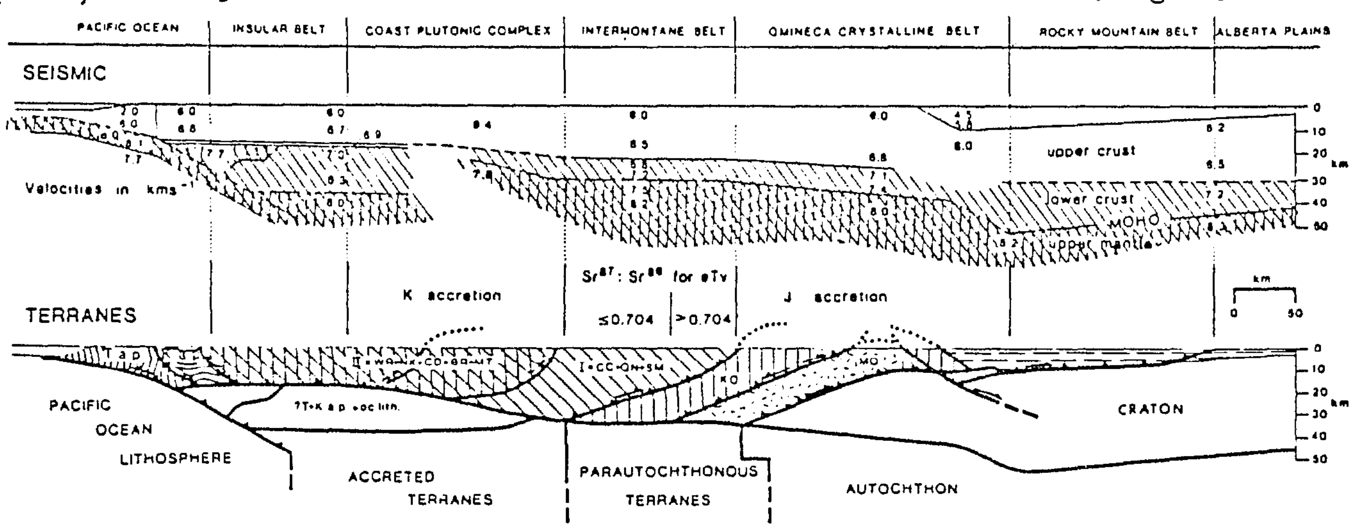


Figure 3: Basis for compiling transect B2. Seismic refraction model was integrated with accreted terrane (I, II) model.

These steps coincide, respectively and possibly fortuitously, with the westernmost part of the Precambrian shield as far west as the point it begins to thin by late, Tertiary extension; an inner, central composite terrane that is entirely intraoceanic in origin, and was accreted to the continental margin in mid-Jurassic time; and a western, outer composite terrane, again entirely composed of intraoceanic rocks, accreted in mid-Cretaceous time. With this in mind, the terranes were treated as Cordilleran "building blocks", and the structural relationships between them at the surface guided interpretation of the structural geometry at deeper levels. The present crustal thicknesses of 35-20km of the western Cordillera, which is underlain largely by the ensimatic accreted terranes, were accounted for by at least three discrete episodes of crustal convergence, as inferred from surface geological relationships which thickened the crust, prior to, during, and after mid-Jurassic accretion, and localized "basin-and-range" style early Tertiary crustal extension which thinned it.

The availability of the above crustal model of the southern Canadian Cordillera was partly responsible for the choice of location for two "Lithoprobe" deep seismic reflection lines. A recent deep seismic reflection study across Vancouver Island, shows the downgoing slab of Pacific Ocean crust beneath the outermost major accreted terrane (Yorath et al., 1985; Clowes et al, in press), and a profile in the eastern Cordillera about 100 km south of the published transect line, showing early compressional structures broken and offset by Tertiary extension faults (Cook et al, in press), have confirmed the general structural pattern depicted for those parts of the transect. This gives hope to transect compilers that if the surface geology and its evolution are well known, reasonable transects can be drawn even though the geophysical coverage in their region may be limited.

REFERENCES

Clowes, R.M., Brandon, M.T., Green, A.G., Yorath, C.J., Sutherland Brown, A., Kanasewich, E.R., and Spencer, C. (in press) Lithprobe, southern Vancouver Island: Cenozoic subduction complex imaged by deep seismic reflections. Canadian Journal of Earth Sciences.

Cook, F.A., Green A.G., Simony, P.S., Price, R.A., Gordy, P.L., Brown, R.L., Parrish, R., Milkereit, B., and Coslin, K.C., (in press): Lithoprobe seismic reflection profiling of southern Canadian Cordillera. Abstract submitted to Cambridge meeting on deep seismic profiling.

Monger. J.W.H., Price, R.A. and Tempelman-Kluit, D.J., (1982): Tectonic accretion and the origin of the two major metamorphic and plutonic welts in the Canadian Cordillera. Geology, 10, 70-75.

Monger, J.W.H., Clowes, R.M., Price, R.A., Simony, P.S., Riddihough, R.P., and Woodsworth, G.J., (1985): B-2: Juan de Fuca Plate to Alberta Plains. Geological Society of America, Centennial continent/ocean transect 7.

Yorath, C.J., Green, A.G., Clowes, R.M., Sutherland Brown A., Brandon, M.T., Kanasewich, E.R., Hyndman, R.D., and Spencer, C., (1985): Lithoprobe, southern Vancouver Island: seismic reflection sees through Wrangellia to the Juan de Fuca plate. Geology, 13, 759-762.

DEEP SEISMIC REFLECTION AND REFRACTION INTERPRETATIONS

D. M. Finlayson
Bureau of Mineral Resources, Geology and Geophysics, Canberra.

Introduction

This position paper seeks to outline the seismic data and interpretations of basement and crustal-scale features now available along the transect and to forecast what further interpretations might reasonably be expected to become available during calender year 1988 for incorporation in the transect. A bibliography of relevant publications appears at the end of this paper. The paper complements the position papers by other authors based on seismic data and interpretations from the sedimentary sections of the Eromanga, Surat and Clarence-Moreton Basins.

Nearly all the controlled-source seismic data available for the interpretation of basement and crustal-scale features are a product of BMR research projects. A map showing the locations of BMR seismic reflection and refraction information is contained in Figure 1. Also indicated in Figure 1 are the BMR seismic projects which, although not on the transect sensu strictu, are relevant to crustal-scale interpretations along the transect. Seismic work in the transect area has also been conducted by ANU and the University of Queensland. Leven (1980) has interpreted ANU wide-angle reflection and refraction data north of the transect in the Deepwater-Moura area of the Bowen Basin. This work complements the BMR seismic work interpreted by Collin (1978,1980) in the same area. The University of Queensland, as part of its earthquake research program, has recorded quarry blasts along a number of short lines in the Esk Trough area and around Brisbane. To date, however, interpretations of these latter data have not been published.

Seismic reflection profiling

A major input to the Eromanga-Brisbane transect is the 20 second seismic reflection data from BMR lines 1, 1X, 9, 14, 15, 16, and 17 extending from Mt. Howitt No.1 well to the Beenleigh Block. These data provide significant controls on the structural features within basement and, taken together with the wide-angle reflection and refraction data, enable depths to these features to be estimated to within plus/minus 2 km in most cases at depths of 30-40 km. The significant deep reflections on these seismic sections have been digitized and Figure 2 is a squeezed time section of these unmigrated digitized events.

Processing of the seismic data has been largely the work of Kevin Wake-Dyster, Mike Sexton and David Johnstone. The software for the digitizing of records was developed by Bruce Goleby and it is expected that software for migration and depth conversion of the digitized data will be implemented during early 1988. It should be noted that experience overseas indicates that the migration of the actual seismic data themselves is largely unsuccessful in producing an improved image of the deep crust. Hence the resort to the creation of digitized line sections. It is expected that the final migrated digitized line sections along BMR Lines 1, 1X, 9, 14, 15, 16, and 17 will be available in the first half of 1988 and that the results will be the basis for the preparation of transect sections.

Other BMR deep seismic reflection data are available along the transect. BMR Lines 1-13 in the central Eromanga Basin (including Lines 1, 1X and 9) have formed the basis of a number of interpretations which will be incorporated in the transect. BMR Lines 18 and 19 on the western Surat Shelf will be incorporated in the transect and will complement interpretations along BMR Line 14 in that area. On the Beenleigh Block BMR shot two short lines during 1986 which will add some control to deep features east of the end of BMR Line 16 which stopped on the western edge of the exposed Beenleigh Block.

North of the transect, in the Denison Trough, BMR recorded five short deep reflection profiles during 1978 which have been interpreted by Mathur (1983). These profiles were between 3 and 15 km long and provide an insight to the nature of the deep crust in that region. They do, in particular, confirm strong reflection events beginning at about 4 s two-way time as are recorded on BMR Lines 14, 18, and 19 further south.

During 1988 it is hoped to model some of the deep reflection events using the Disco ISMS modelling sotware available on the BMR seismic processing system. This should give some idea of the sorts of structures which might be causing some deep reflections.

Wide-angle reflection and refraction profiling

Wide-angle reflection and refraction profiles provide the control on average velocities throughout the crust along the transect. The locations of these profiles are indicated in Figure 1. The data providing the most conclusive control on average velocities are from the central Eromanga Basin where two orthogonal traverses, each more than 300 km long, enable interpretation of velocities to depths of about 60 km. Upper mantle velocities are well determined and the control on Moho depth is good and can be tied to coincident reflection profiling. Intra-crustal velocity structure is also well controlled and enables features evident in the reflection profiles to be tied to velocity features.

Over the Nebine Ridge, coincident with BMR reflection Line 14, there are two sources of information on crustal velocities. The first is an east-west wide-angle reflection and refraction profile about 200 km long which has been interpreted by Finlayson and Collins (1987) in terms of velocities to lower crustal depths. The profile did not record upper mantle refracted phases so there must remain some uncertainty about the depth to the Moho and the upper mantle velocity. The second source of information on crustal velocities is derived from expanding-spread recordings interpreted by Wright and Finlayson (1988). These data provide local P and S-wave velocity values to mid-crustal depths over the shallowest part of the Nebine Ridge on BMR reflection Line 14.

In the western Surat Shelf area, coincident with BMR reflection profiles 14 and 18, BMR wide-angle reflection and refraction recordings were made during 1986. One line was east-west and the other north-south with a maximum recording distance of about 150 km. In addition, shots were recorded in a fan shooting arrangement to assist control on lateral changes in structure. At this time only preliminary interpretations are available, but it is expected that final results will be available during 1988.
At this stage it seems unlikely that this data set will provide control on Moho depths but this could change with more detailed examination of data.

Within the Taroom Trough there are no wide-angle reflection and refraction data to control the velocity structure within the crust along BMR reflection Line 14. North of the transect there are data from the Bowen Basin which have been interpreted by Collins (1978, 1980) and Leven (1980). These latter interpretations can be used only as a guide to velocity structures within the deepest Permo-Triassic basins in the region of BMR reflection Line 14. Along this latter reflection line there are expanding-spread data which have not yet been interpreted. These data may give some indication of upper crustal velocities but it is too early to say how much control they will provide. It is expected that some progress will be made in the interpretation of these data during 1988 (Wright, pers comm).

During 1984 BMR recorded wide-angle reflection and refraction data across the New England Block from Woolbrook in the south to Warwick in the north. Offset shots were also fired at Oakey near the BMR reflection Line 14, and in the Hunter Valley (coal blasts) in the south. Maximum recording distances exceeded 400 km and the data provide the best information to date on the average velocity structure wholely within the New England Orogen. The data are still being interpreted in BMR but this should be completed during 1988.

The University of Queenland made a number of recordings along profiles in the region of the Wivenhoe Dam on the Brisbane River. These profiles used quarry shots associated with dam construction and recording distances usually did not exceed 50 km. It is therefore likely that only average upper crustal velocities can be controlled from this data set. The data are still being interpreted (Rynn, pers comm).

<u>Comment</u>

There are two aspects of the deep seismic work which must receive attention for the purpose of transect compilation. The first is the strictly seismological problem of obtaining the most reasonable seimological interpretation of the data. In this respect there must be some effort put into completing the interpretation of wide-angle reflection and refration data in the New England and western Surat Shelf areas, and of the expanding-spread data in a number of locations. Also there must be some effort made to model deep reflection features which might reasonably be attributed to major structures at depth. This can be done in BMR on the Disco ISMS modelling facility. There are only a few areas along the traverse where cross-line reflection data enable an attempt to be made at such modelling, but these opportunities should be taken. Even if negative results are achieved, it will still be instructive to get some feel for the sorts of structures likely to be causing deep reflections.

The second aspect of deep seismic work which requires attention is the integration of deep seismic results with seismic data from the sedimentary sections of the Eromanga, Surat, and Clarence-Moreton Basins and their underlying basins. It is often difficult to interpret the deep seismic data along single traverses if there is no concept of the basin-forming processes involved. A good indication of these processes is achieved from the interpretation of exploration seismic profiles along close-spaced lines and from basement outcrop. It is therefore essential that concepts must be put forward and tested using combined shallow and deep seismic data.

It would be presumptuous in this short position paper to try to describe all the detail in the deep seismic data which must be incorporated in any interpretation of transect data. However, some features do stand out as being of major significance and are therefore listed below.

1. The seismic reflection data along the transect are of excellent quality and provide impressions of the deep crust which must be interpreted in geological terms. Only along the part of the traverse which crosses the Tertiary basalts west of Toowoomba is there some doubt about the penetration of seismic energy. Even there the impression of a Moho reflector is partly achieved but any interpretation should not be weighted in favour of data in that region.

2. In the central Eromanga Basin the basement data are characterized by a non-reflective upper crust overlying many subhorizontal reflections in the lower crust between about 7 and 12 seconds two-way time. These lower crustal reflections change in character and amplitude under basement highs.

3. The non-reflective upper crust tends to be evident in one form or another as far east as the Roma Shelf, being progressively invaded by events from the lower crust.

4. East of the Roma Shelf reflections tend to occur at all levels in the crust, especially under the western Surat Shelf and the New England Fold Belt. Under the Taroom Trough there tends to be few prominent crustal reflectors at depth.

5. Ignoring the dipping reflectors at depths greater than 12 seconds which are likely to migrate to shallower depths, there is a strong indication of an almost continuous 'package' of Moho reflections at 12-13 seconds east of the Westgate Trough. The 'package' undulates in places but does not seem to have major offsets along its length.

6. Under the central Eromanga Basin the 'package' of Moho reflections is less clear and the Moho is better characterized by an extinction of the deep crustal reflections.

7. The seismic data across the Burunga and Moonie Faults on the eastern boundary of the Taroom Trough and across the Grenfield Fault at the southern boundary of the Adavale Basin seem to be characterized by 'tranparent' zones which might indicate major steep-angled faults penetrating the entire crust.

8. There does not seem to be any deep seismic reflection evidence of major shallow angle faulting extending from the surface into the lower crust.

9. Many of the strongest changes in reflection character can be shown to be associated with average velocity changes evident in wide-angle seismic work. Examples include the mid-crustal (22-24 km depth) velocity increase under the central Eromanga Basin, and the velocity increase at about 12 km depth under the western Surat Shelf.

10. The upper mantle velocity under the New England Fold Belt (7.7 km/s) appears to be very much lower than that under the Bowen and Eromanga Basins further west (7.98-8.22 km/s and 8.15 km/s respectively).

11. There is a strong increase in P-wave velocity evident at 22-24 km depth under the central Eromanga Basin but this feature is not evident further east under the Nebine Ridge, Bowen Basin, or New England Fold Belt.

12. The average crustal velocity under the New England Fold Belt is in the range 6.03-6.45 km/s (depth range 2.5-32.0 km), significantly less than that further west.

Bibliography

This bibliography of deep seismic research from the transect area does not claim to be complete but it does contain the more important references from which others may be traced.

Collins, C.D.N., 1978 - The crustal structure of the central Bowen Basin, Queensland. BMR J. Aust. Geol. & Geophys., 3, 203-209.

Collins, C.D.N., 1980 - The crustal structure of the central Bowen Basin from deep seismic sounding. MSc Thesis, Unversity of Queensland (unpublished).

Collins, C.D.N., & Lock, J., 1983 - A seismic refraction study of the Quilpie Trough and adjacent basement highs, Eromanga Basin, Queensland, Australia. Tectonophysics, 100, 185-198.

Drummond, B.J., & Collins, C.D.N., 1986 - Seismic evidence for underplating of the lower continental crust of Australia. Earth and Plan. Sc. Lett., 79, 361-372.

Finlayson, D.M., 1983 - The mid-crustal horizon under the Eromanga Basin, eastern Australia. Tectonophysics, 100, 199-214.

Finlayson, D.M., & Collins, C.D.N., 1986 - Lithospheric velocity beneath the Adavale Basin, Queensland, and the character of deep crustal reflections. BMR J. Aust. Geol. & Geophys., 10, 23-37.

Finlayson, D.M., & Collins, C.D.N., 1987 - Crustal differences between the Nebine Ridge and the central Eromanga Basin from seismic data. Aust. J. Earth Sc., 34, 251-259.

Finlayson, D.M., Collins, C.D.N., & Lock, J., 1984 - P-wave velocity features of the lithosphere under the Eromanga Basin, eastern Australia, including a prominent mid-crustal (Conrad?) discontinuity. Tectonophysics, 101, 267-291.

Finlayson, D.M., & Leven, J.H., 1987 - 3-dimensional image of the lower crust under an intra-continental basin in eastern Australia. Expl. Geophys., 18, 49-52.

Finlayson, D.M., & Leven, J.H., 1987 - Lithospheric structures and possible processes in Phanerozoic eastern Australia from deep seismic investigations. Tectonophysics, 133, 199-215.

Finlayson, D.M., Leven, J.H., & Etheridge, M.A., 1988 - Structural styles and basin evolution in the Eromanga region, eastern Australia. AAPG Bull, 72, 33-48.

Finlayson, D.M., & Mathur, S.P., 1984 - Seismic refraction and reflection features of the lithosphere in northern and eastern Australia, and continental growth. Annales Geophysicae, 2(6), 711-722.

Finlayson, D.M., Leven, J.H., Mathur, S.P., & Collins, C.D.N., 1987 - Geophysical abstracts and seismic profiles from the central Eromanga Basin region, eastern Australia. Bur. Miner. Resour. Aust. Report, 278.

Finlayson, D.M., Leven, J.H., Sexton, M.J., Wake-Dyster, K.D., & Mathur, S.P., 1988 - Large-scale lenticles in the lower crust under an intra-continental basin in eastern Australia. In, Lower Crust Properties and Processes; Proceedings of 1987 IUGG Symposium U7, AGU Geodynamics Series Monograph, in press.

Finlayson, D.M., Wright, C., Leven, J.H., Collins, C.D.N., Wake-Dyster, K.D., & Johnstone, D.W., 1988 - Basement features under four intra-continental basins in central and eastern Australia. In, Origin and Evolution of Sedimentary Basins and their Energy and Mineral Resources; Proceedings of 1987 IUGG Symposium U19, AGU Geodynamics Series Monograph, in press.

Johnstone, D.W., Sexton, M.J., & Wake-Dyster, K.D., 1985 - A geophysical transect across the Clarence-Moretton Basin. Expl. Geophys., 16, 241-244.

Korsch, R.J., Lindsay, J.F., O'Brien, Sexton, M.J., & Wake-Dyster, K.D., 1986 - Deep crustal seismic reflection profiling, New England orogen, eastern Australia: telescoping of the crust and a hidden, deep, layered sedimentary sequence. Geology, 14, 982-985.

Leven, J.H., 1980 - The application of synthetic seismograms to the interpretation of crustal and upper mantle structure. PhD Thesis, Australian National University (unpublished).

Leven, J.H., & Finlayson, D.M., 1987 - Lower crustal involvement in upper crustal thrusting. Geophys. J. Roy. Astron. Soc., 89, 415-422.

Lock, J., & Collins, C.D.N., 1983 - Velocity/depth modelling using reflection and refraction data in the central Eromanga Basin, Queensland, Australia. Tectonophysics, 100, 175-184.

Lock, J., Collins, C.D.N., & Finlayson, D.M., 1986 - Basement structure and velocities under the Eromanga Basin from seismic refraction studies. Geol. Soc. Aust. Sp. Pub., 12, 155-162.

Mathur, S.P., 1983 - Deep crustal reflection results from the central Eromanga Basin, Australia. Tectonophysics, 100, 163-173.

Mathur, S.P., 1983 - Deep reflection probes in eastern Australia reveal differences in the nature of the crust. First Break, 1(7), 9-16.

Mathur, S.P., 1983 - Deep reflection experiments in northeastern Australia. Geophysics, 48, 1588-1597.

Mathur, S.P., 1984 - Improvements in seismic reflection techniques for studying the lithosphere in Australia. Tectonophysics, 105, 373-381.

Moss, F.J., & Wake-Dyster, K.D., 1983 - The Australian central Eromanga Basin project; and introduction. Tectonophysics, 100, 131-145.

Moss, F.J., & Mathur, S.P., 1986 - A review of continental reflection profiling in Australia. In, Reflection Seismology: a Global Perspective, AGU Geodynamics Series, 13, 67-76.

Sexton, M.J., Wake-Dyster, K.D., & Johnstone, D.W., 1988 - Seismic reflection profiling on the Beenleigh Block, Queensland. Geol. Soc. Aust. Abstracts Series, in press.

Wake-Dyster, K.D., Moss, F.J., & Sexton, M.J., 1983 - New seismic reflection results in the central Eromanga Basin, Queensland, Australia; the key to understanding its tectonic evolution. Tectonophysics, 100, 147-162.

Wake-Dyster, K.D., Sexton, M.J., & Johnstone, D.W., 1985 - Lithospheric transect study of southeastern Queensland. Expl. Geophys., 16, 312-316.

Wake-Dyster, K.D., Sexton, M.J., Johnstone, D.W., Wright, C., & Finlayson, D.M., 1987 - A deep seismic profile of 800 km length recorded in southern Queensland, Australia. Geophys. J. Roy. Astron. Soc., 89, 423-430.

Wake-Dyster, K.D., Sexton, M.J., Johnstone, D.W., Wright, C., & Finlayson, D.M., 1987 - Deep seismic profiling across the Nebine Ridge, Surat Basin, Kumbarilla Ridge and Clarence-Moreton Basin in southern Queensland. Expl. Geophys., 18, 218-222.

Wake-Dyster, K.D., Sexton, M.J., Johnstone, D.W., & Finlayson, D.M., 1988 - Seismic features of the Thomson Fold Belt under the western Surat Basin. Geol. Soc. Aust. Abstracts Series, in press

Wright, C., & Finlayson, D.M., 1988 - Refracted and reflected shear waves recorded on an expanding spread reflection profile. J. Geophys. Res., in press.

DEEP SEISMIC PROFILES, SOUTHERN QUEENSLAND

Fig. 1

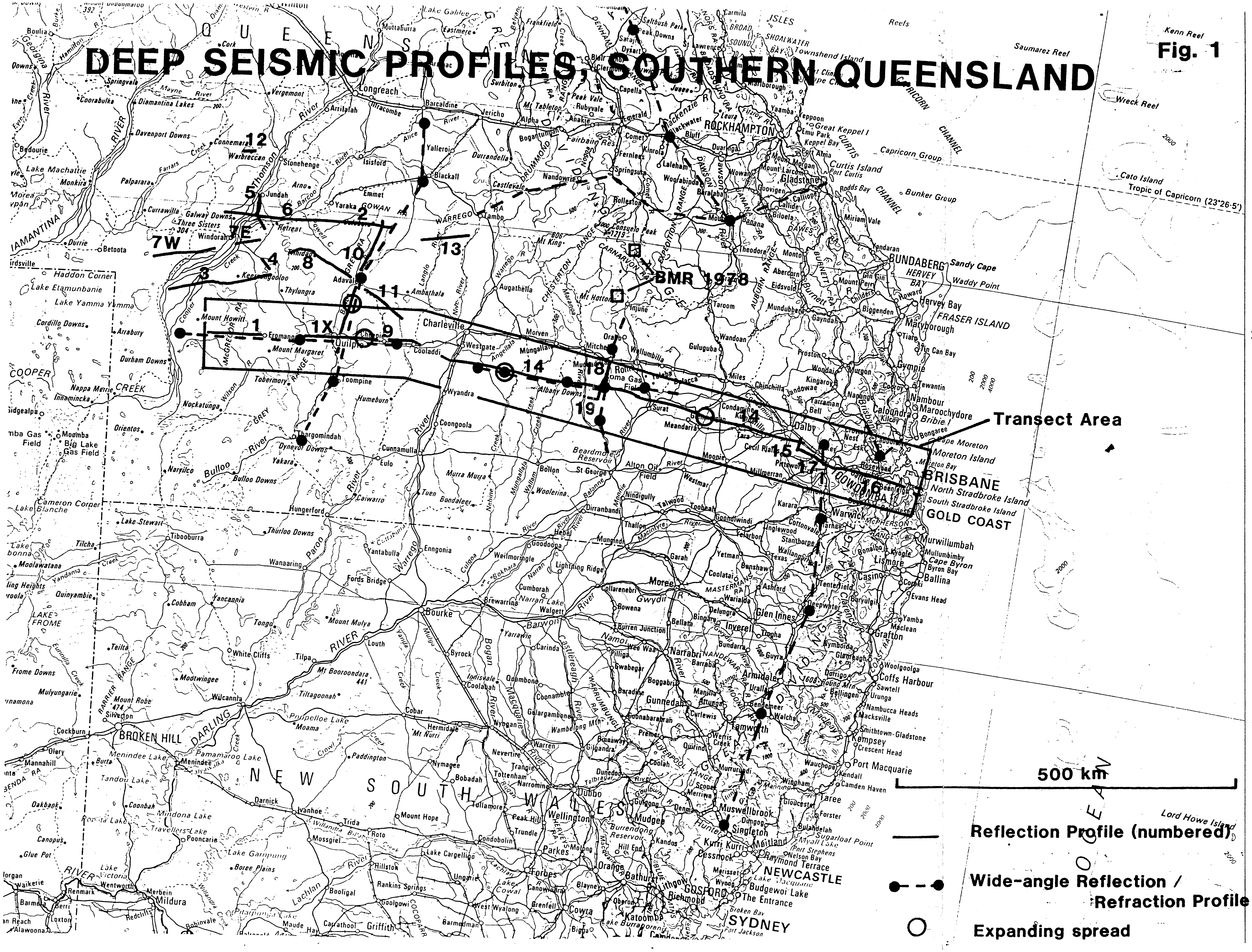
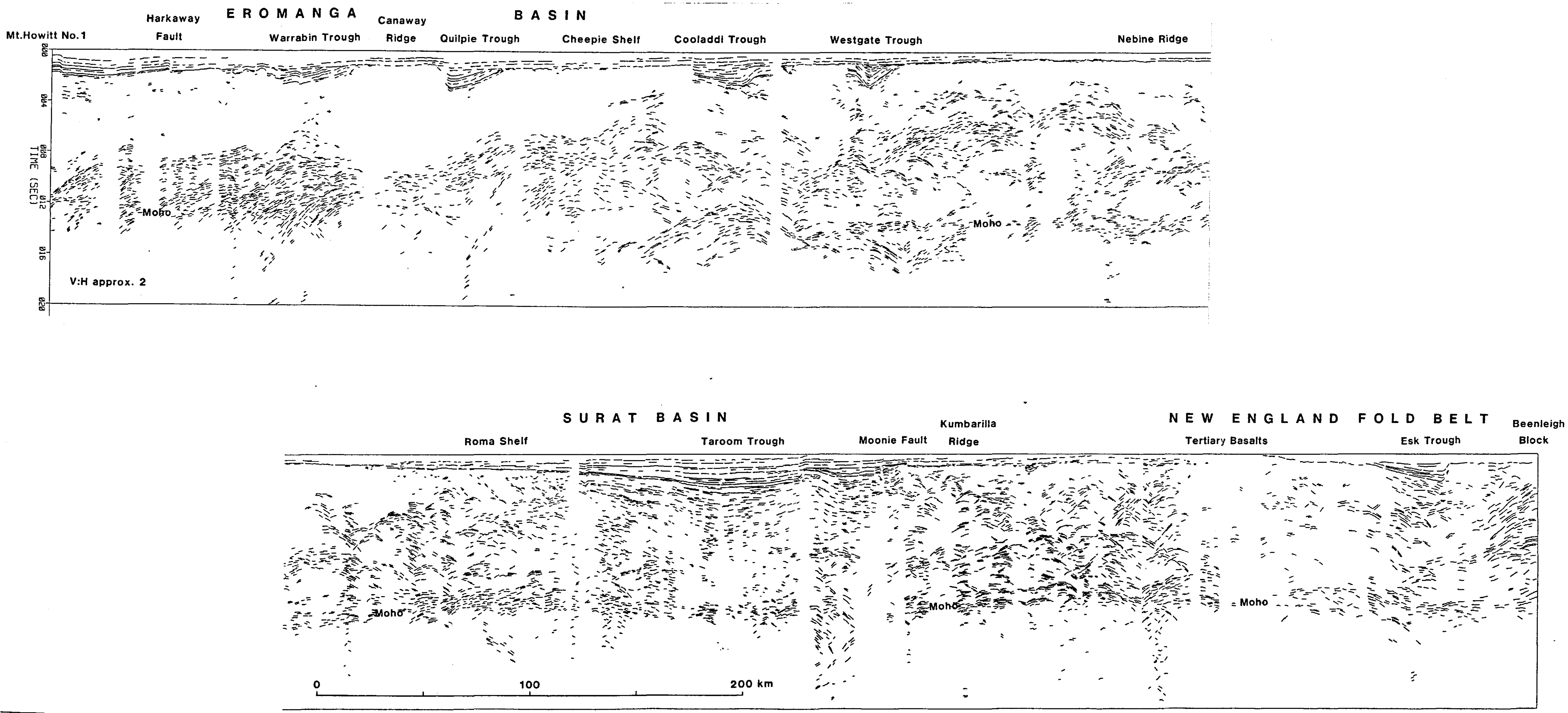


Fig. 2

EROMANGA - BRISBANE GEOSCIENCE TRANSECT, EASTERN AUSTRALIA



STRUCTURE AND TECTONICS OF THE THOMSON FOLD BELT

C. G. Murray
Queensland Department of Mines, Brisbane

INTRODUCTION

In the transect area, the Thomson Fold Belt is completely concealed beneath Mesozoic sediments of the Great Artesian Basin. Information on the basement rocks is available only from basement cores of petroleum exploration wells and geophysical surveys. Any model for the structure and tectonic evolution of the fold belt must therefore be extremely speculative.

Limits

(a) NW - Diamantina River Lineament, expressed as sharp aeromagnetic and gravity gradients (see attached figure). If the Proterozoic rocks of the Mount Isa Inlier continue SE of the lineament, they have been downfaulted at least 10 km to attenuate the associated magnetic anomalies. The regions on either side of the lineament now have quite different crustal structures (crustal thickness 55 km to the NW compared with 36-41 km to the SE).

(b) E - boundary with the New England Fold Belt is concealed beneath the Bowen Basin.

(c) S - boundary with the Lachlan Fold Belt is uncertain, and the two fold belts may be continuous and related.

Geology

(a) W of the Nebine Ridge

1. **Early Palaeozoic basement** consists dominantly of interbedded quartzose sandstone, siltstone and mudstone sourced from a plutonic/metamorphic terrain. The varied basement lithologies beneath the Cooper Basin in South Australia, including carbonates and volcanics (Gatehouse, 1986), have not been sampled in the transect area. The rocks have been multiply deformed and metamorphosed (mainly lower greenschist facies). An early Palaeozoic age is suggested by correlation with the fossiliferous sequences in South Australia, by Silurian metamorphic ages (425 Ma from Buckabie 1 at the southern end of the Adavale Basin and 416 Ma from Alba 1 on the Nebine Ridge), and by Silurian-Devonian ages ranging from 368 to 426 Ma on intrusive granites.

2. The **Adavale Basin** and **Warrabin Trough** contain more than 3000 m of Devonian sediments and volcanics which overlie the early Palaeozoic basement unconformably. Early and Middle Devonian deposits are continental volcanics and fluviatile to shallow marine sediments, including extensive carbonates and evaporites. The volcanics range from basalt to rhyolitic ignimbrite and appear to be dominantly andesitic. By the Late Devonian, continental redbed sedimentation covered the whole area and extended into

the Drummond Basin. Most boundaries shown on the figure are erosional or faulted, and the present subcrops are only remnants of the original depositional basin. The Devonian strata are essentially undeformed.

(b) E of the Nebine Ridge

Basement rocks have been grouped as the **Timbury Hills Formation**, consisting of quartzose sandstones and siltstones interbedded with cleaved argillite. In most cases bedding and slaty cleavage are parallel, suggesting isoclinal folding, and dip steeply. Metamorphic grade is lower greenschist facies. A Devonian age is indicated by fossil plants from Pickanjinnie 2 (Traves, 1966) and by Early Carboniferous dates from the post-orogenic **Roma granites** (maximum age 355 Ma). Both the Timbury Hills Formation and Roma granites are overlain by the **Combarngo Volcanics**, which are andesitic to rhyolitic in composition, flat-lying, and of probable Late Carboniferous-earliest Permian age.

Structure

N of the transect area, the dominant trend in the subsurface Thomson Fold belt, as indicated by gravity anomalies, folds and faults in cover rocks, and depositional basin margins, appears to be NE. In the transect area, NE trends persist (eg. Nebine Ridge), but there is also a later NW fault trend affecting both Palaeozoic and Mesozoic sequences. Faults cutting Mesozoic strata can be shown to be re-activated older structures.

Tectonic Evolution

(a) Pre-Devonian (pre-cratonic or orogenic stage)

It is assumed that the Thomson Fold Belt formed by rifting or stretching of the Proterozoic craton SE of the Diamantina River Lineament. Three different models can be envisaged.

1. Complete removal of the Precambrian craton by rifting and sea floor spreading.

This requires that the entire fold belt was an oceanic area. Although there is evidence for an oceanic setting for at least part of the Anakie Inlier (serpentinites, mafic volcanics, Besshi or Kieslager style volcanogenic mineralisation), it is not considered possible that this was the case for the whole of the fold belt because (i) subsurface basement rocks had a plutonic/metamorphic source, and (ii) uplift of much of the fold belt above sea level by the beginning of the Devonian would have required an unbelievably large rate of continental accretion in the early Palaeozoic.

2. Removal of fragments of Precambrian craton and creation of a marginal sea (eg. Nebine Island Arc and Barcoo Marginal Sea of Harrington, 1974).

This model is also considered impossible because seismic data (including the BMR deep seismic reflection line through the transect area) clearly indicates that there are no anomalous zones of crustal structure which could be equated with the Precambrian fragments.

3. The Thomson Fold Belt is largely if not completely floored by stretched and thinned Precambrian continental crust.

This model is favoured. It is possible that the thinned Precambrian crust is now represented by the layered lower crust evident on seismic reflection profiles. The layering may be due to intrusion of sill-like bodies (underplating) or to horizontal shearing of contrasting lithologies.

(b) Devonian (transitional stage)

The origin of the Adavale Basin and its contained volcanics is problematical. A rift model, as proposed for rocks of similar age in the Lachlan Fold Belt, is supported by its intra-cratonic position and the widespread occurrence of evaporites. However, petrographic examination of the volcanics suggests that they are dominantly andesitic or andesitic-dacitic, and not bimodal. This supports a subduction related continental margin arc model. The arc presumably would have trended NE to include small outcrops along the E side of the Anakie Inlier, and must have been 300 km or more from the continental margin (at least as far E as the Nebine Ridge).

The tectonic setting of the Timbury Hills Formation is unknown. This unit is isoclinally folded and steeply dipping, whereas coeval rocks of the Adavale Basin are undeformed.

Problems and Possible Lines of Research (any volunteers?)

1. Aeromagnetic and gravity interpretations such as those of Stevens (1985) and Agostini (1987) to the S.

2. Detailed structural studies, petrography, and modal and geochemical analyses of basement cores.

3. Detailed petrography and geochemical analysis of volcanics from the Adavale Basin to determine their tectonic setting.

4. Detailed petrography and geochemical analysis of the Combarngo Volcanics to compare them with Late Carboniferous volcanics in the western part of the Tamworth Belt in the New England Fold Belt.

5. Geochemical analysis of Roma granites to determine whether these two mica granites are S-type.

SELECTED BIBLIOGRAPHY

(a) General

KIRKEGAARD, A.G., 1974: Structural elements of the northern part of the Tasman Geosyncline. **In** Denmead, A.K., Tweedale, G.W., & Wilson, A.F. (eds), The Tasman Geosyncline - A Symposium. Geological Society of Australia, Queensland Division, Brisbane, pp. 47-62.

MURRAY, C.G., & KIRKEGAARD, A.G., 1978: The Thomson Orogen of the Tasman Orogenic Zone. Tectonophysics, **48**, 299-325.

HENDERSON, R.A., 1980: Structural outline and summary geological history for northeastern Australia. **In** Henderson, R.A., & Stephenson, P.J. (eds), The Geology and Geophysics of Northeastern Australia. Geological Society of Australia, Queensland Division, Brisbane, pp. 1-26.

MURRAY, C.G., 1986: Metallogeny and tectonic development of the Tasman Fold Belt System in Queensland. Ore Geology Reviews, **1**, 315-400.

(b) Early Palaeozoic basement

STEVENS, B.P.J., 1985: Preliminary interpretation of regional basement geology in northwestern New South Wales. New South Wales Geological Survey Quarterly Notes, **61**, 9-22.

GATEHOUSE, C.G., 1986: The geology of the Warburton Basin in South Australia. Australian Journal of Earth Sciences, **33**, 161-180.

AGOSTINI, A., 1987: Walgett 1:250 000 Sheet - A geological interpretation from regional aeromagnetic and gravity data. New South Wales Geological Survey Quarterly Notes, **66**, 21-31.

(c) Adavale Basin

HEIKKILA, H.H., 1966: Palaeozoic of the Adavale Basin. **In** Madigan, R.T., Thomas, R.G., & Woodcock, J.T. (eds), Publications - Volume 5, Proceedings - Petroleum. 8th Commonwealth Mining and Metallurgical Congress, Melbourne, pp. 157-165.

TANNER, J.J., 1967: Devonian of the Adavale Basin. **In** Oswald, D.H. (ed.), International Symposium on the Devonian System, II. Alberta Society of Petroleum Geologists, Calgary, pp. 111-116.

AUCHINCLOSS, G., 1976: Adavale Basin. **In** Leslie, R.B., Evans, H.G., & Knight, C.L. (eds), Economic Geology of Australia and Papua New Guinea. 3 - Petroleum. Australasian Institute of Mining and Metallurgy Monograph, **7**, 309-315.

PATEN, R.J., 1977: The Adavale Basin, Queensland. **In** Petroleum in Queensland - A Stocktake for the Future. Petroleum Exploration Society of Australia, Queensland Division, Brisbane.

PASSMORE, V.L., & SEXTON, M.J., 1984: The structural development and hydrocarbon potential of Palaeozoic source rocks in the Adavale Basin region. APEA Journal, **24(1)**, 393-411.

(d) Warrabin Trough

PINCHIN, J., & SENIOR, B.R., 1982: The Warrabin Trough, western Adavale Basin, Queensland. Journal of the Geological Society of Australia, **29**, 413-424.

PASSMORE, V.L., & SEXTON, M.J., 1984: The structural development and hydrocarbon potential of Palaeozoic source rocks in the Adavale Basin region. APEA Journal, **24(1)**, 393-411.

(e) Timbury Hills Formation

TRAVES, D.M., 1966: Petroleum in the Roma-Springsure area. **In** Madigan, R.T., Thomas, R.G., & Woodcock, J.T. (eds), Publications - Volume 5, Proceedings - Petroleum. 8th Commonwealth Mining and Metallurgical Congress, Melbourne, pp. 147-154.

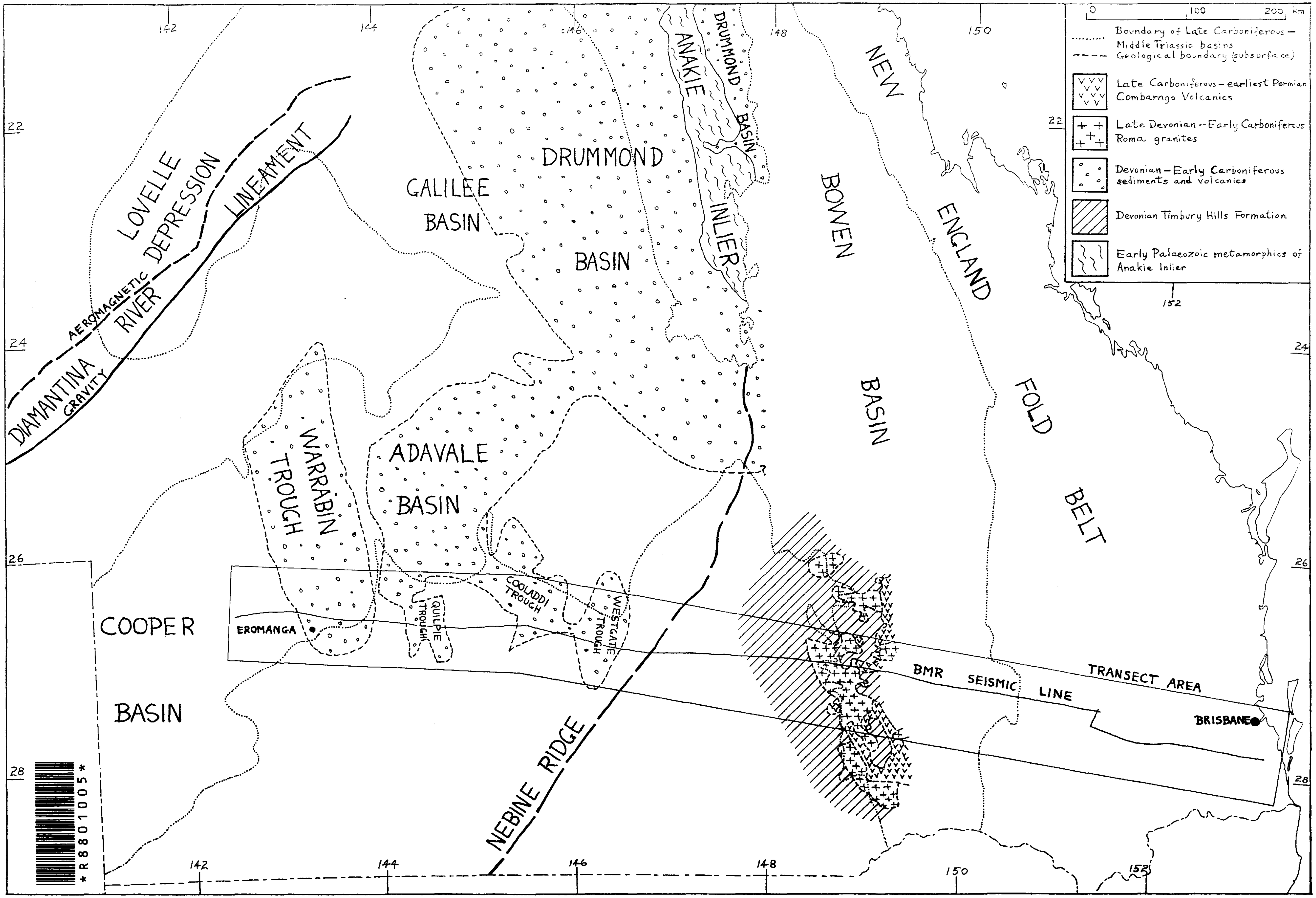
(f) Roma granites

HOUSTON, B.R., 1964: Petrology of intrusives of the Roma Shelf. Geological Survey of Queensland Report, **7**.

(g) Tectonic Evolution

HARRINGTON, H.J., 1974: The Tasman Geosyncline in Australia. **In** Denmead, A.K., Tweedale, G.W., & Wilson, A.F. (eds), The Tasman Geosyncline - A Symposium. Geological Society of Australia, Queensland Division, Brisbane, pp. 383-407.

VEEVERS, J.J., JONES, J.G., & POWELL, C.McA., 1982: Tectonic framework of Australia's sedimentary basins. APEA Journal, **22(1)**, 283-300.


0 100 200 km
Boundary of Late Carboniferous – Middle Triassic basins
Geological boundary (subsurface)
Late Carboniferous – earliest Permian Combarngo Volcanics
Late Devonian – Early Carboniferous Roma granites
Devonian – Early Carboniferous sediments and volcanics
Devonian Timbury Hills Formation
Early Palaeozoic metamorphics of Anakie Inlier
LOVELLE DEPRESSION
AEROMAGNETIC
DIAMANTINA GRAVITY
RIVER LINEAMENT
GALILEE BASIN
DRUMMOND BASIN
ANAKIE INLIER
DRUMMOND BASIN
BOWEN BASIN
NEW ENGLAND FOLD BELT
WARRABIN TROUGH
ADAVALE BASIN
QUILPIE TROUGH
COOLADDI TROUGH
WESTGATE TROUGH
COOPER BASIN
EROMANGA
NEBINE RIDGE
BMR SEISMIC LINE
TRANSECT AREA
BRISBANE
142
144
146
148
150
152
22
24
26
28

GRAVITY AND MAGNETIC INTERPRETATION

P. Wellman & R. J. Korsch
Bureau of Mineral Resources, geology and Geophysics, Canberra.

DATA

Aeromagnetic surveys cover the area east of 150°E, although the data north of 28oN has not yet been released. These surveys have east-west traverses spaced 1.5 km apart. They were by Geol. Surv. of NSW, and by BMR.

A regional gravity survey covers the whole area; it has a grid spacing of 11 km. More detailed surveys cover the whole of the sedimentary area of the Clarence-Moreton Basin. The more detailed surveys are: west of Ipswich by A.R. Maher and other students of the University of Queensland, near Ipswich by Queensland Petroleum Pty Ltd, west of Ipswich by J.W. Williams of BMR, and along the deep seismic lines by BMR.

DATA PRESENTATION

It is planned to produce new maps at 1:1M scale that present the gravity and magnetic information in a form more suitable for geological interpretation Magnetic data will be reduced to produce smoothed contour maps, and pixel maps of the anomaly and its gradient. Gravity data will be presented as contours of the second vertical derivative of the isostatic anomaly.

INTERPRETATION

Both gravity and magnetic anomalies appear to mainly reflect anomalous bodies in the basement. Short-wavelength (~1 km) magnetic anomalies prove useful in mapping the strike of the basement rocks. Medium-wavelength gravity and magnetic anomalies allow mapping of elongate bands (10 - 30 km wide) that approximate the tectono-stratigraphic associations. A paper presenting and interpreting the data in terms of basement structure is expected to be completed in 1988.

PALAEOMAGNETISM

C. T. Klootwijk
Bureau of Mineral Resources, Geology and Geophysics, Canberra.

SCOPE

Palaeomagnetic research relevant to the transect has concentrated at large on the southern part of the New England Fold Belt. BMR initiated a project in 1984 with the initial aim to test the Permo-Carboniferous orocline hypothesis throughout the Texas Coffs Harbour and Beenleigh Blocks, the origin of the bend in the Tamworth Belt between the Rocky Creek Syncline-Werrie Syncline and the Hunter-Myall region, and the possibility of large-scale displacement of the New England Fold Belt with respect to the already cratonized part of the Tasman Fold Belt. This project is expanding now in to the northern part of the New England Fold Belt, a.o. the Gympie terrane. The CSIRO-Macquarie University group initiated lately a study of the Late Permian ignimbritic Dundee Rhyodacite and comagmatic granites of the Moonbi Suite (Lackie 1988), and a test on displacement of the New England Fold Belt (Schmidt 1988).

RESULTS TODATE AND PRELIMINARY INTERPRETATION

A reconnaissance collection of 330 samples was taken from turbiditic sequences of probable Late Carboniferous age from the Texas Beds and from the possibly Late Carboniferous Coffs Harbour sequence, with broad coverage of the continuing variation in strike along the Z-shaped megafold. The magnetization of these rocks proved to be dominated by a steeply west to southwest downward directed magnetization of exclusively reversed polarity, which is of post-tectonic and probably Early Permian origin. The directions of this secondary component as observed so far in pilot specimens do not show any significant change in declination along the megafold. No primary magnetization could be identified and the palaeomagnetic test on the origin of the New England Orocline is so far inconclusive. Bulk demagnetization treatment and a more in-depth analysis of data is in progress.

In the Rouchel region of the Tamworth Belt a reconnaissance collection of 130 samples was taken from Lower Carboniferous carbonate and siltstone of the Brushy Hill Limestone and the Woolooma Formation, and from ignimbrites of the Visean Isismurra Formation. A secondary magnetization similar to the one observed in the Texas and Coffs Harbour Blocks predominated the magnetization content. However, seven out of ten sites from the Isismurra ignimbrites showed in adition a north to northwest directed component of very low inclination and of both normal and reversed polarity. The equatorial palaeolatitude indicated by this result is in agreement with the low-latitude palaeo-environment and this magnetization is interpreted, therefore, to be of primary origin. Confirmation of the pre-tectonic origin of this magnetization through a statistically significant fold test has not yet been possible for reason of the limited number of sites and the generally shallow dip of the flows. Preliminary results from andesitic flows/sills in the Lower Carboniferous Merlewood Formation of the Werrie Syncline (Schmidt 1988) are grossly similar to the above results for the Isismurra Formation. A negative fold test reported by Schmidt may be more relevant to settle the disputed sill/flow origin of the andesitic bodies, rather than by interference suggest a secondary origin for the equatorial Isismurra result. This question is being addressed in a current large-scale study on Carboniferous volcanics throughout the Tamworth Belt.

The result for the Visean Isismurra Formation and to some extent for the Early Carboniferous Merlewood Formation of the Tamworth Belt differ considerably from the Late Palaeozoic APWP for Australia as proposed by Schmidt et al. (1986; Fig.1), whereas latest Carboniferous results from the Tamworth Belt (Irving 1966, currently reinvestigated) show no disagreement. On this basis a large-scale post- or possibly syn-Visean but pre-latest Carboniferous southward displacement of the New England region east of the Mooki Fault Zone relative to (neo-) cratonic Australia was tentatively proposed (Klootwijk 1985). The value of such a comparison is hampered by uncertainty about the shape of the Devono-Carboniferous APWP for Australia. Data are few, both for Australia and as well as for Gondwana, and effects of Carboniferous remagnetizations are not yet fully understood. New results from the Cowra Trough-Molong High of the Lachlan Fold Belt and from the Ngalia Basin of central Australia have been interpreted by the BMR group in terms of an alternative Middle Silurian to late Carboniferous APWP (Klootwijk 1987,1988; Fig.2) which differs substantially from the Schmidt et al. (1986,1988; Fig.1) APWP. A new feature in this alternative APWP is recognition of an Early to Middle Carboniferous southeastern (Fig.2) rather than southwestern (Fig.1) loop, which reflects widespread effects of Kanimblan age overprinting. This southeastern loop in the alternative APWP agrees well with pole positions obtained so far for the Visean Isismurra Formation, and shows no evidence for large-scale latitudinal displacement in excess of the palaeomagnetically detectable level (about 500 km).

APWP FRAMEWORK AND FURTHER NEW ENGLAND STUDIES.

Conclusions drawn from comparison of the New England data and the Australian APWP are as valid as the reliability of both datasets. Current studies by both the BMR and the CSIRO-Macquarie University group address this question.

Recent studies by the CSIRO-MU group on the Early Devonian Snowy River Volcanics (Schmidt et al. 1987) and on the Devono-Carboniferous Hervey Group (Zheng Xiang Li 1987, Zheng Xiang Li et al. 1988) of the Lachlan Fold Belt have been interpreted in terms of the Schmidt et al. APWP. Results from a joint BMR-CSIRO-MU study on Devono-Carboniferous greywackes and red beds from the Ngalia Basin have so far been interpreted by the BMR group in support of the alternative APWP. The CSIRO-MU group has not yet identified a relevant primary magnetization component (Zheng Xiang Li 1987, Zheng Xiang Li et al. 1988), and interpretes the BMR group's identification as a pssudo-component. Thus there is at present a difference in interpretation of these data. The BMR group is currently conducting APWP framework studies on the Early Devonian Boggy Plain suite, Middle to Late Silurian Volcanics and Early Devonian red beds and carbonates from the Cowra Trough-Molong High, and is starting up studies on Devono-Carboniferous sequences of the Drummond Basin and Bonaparte Basin.

In the New England region the BMR has recently started up an extensive study of Carboniferous volcanics throughout the Tamworth Belt, i.e Rocky Creek Syncline, Werrie Syncline, Hunter-Myall region, to further define Early and Late Carboniferous pole positions for the southern New England region. For comparison a study on Carboniferous acid volcanics of NE Queensland has been initiated. Additional studies on the origin of the New England Orocline are being carried out on a.o. the Bundara batholith, Permian volcanics in the Texas Block, the Drake Volcanics and the Beenleigh sequence. Permian Volcanics of the Gympie terrane are studied to investigate a surmised exotic origin of this terrane.

REFERENCES

Goleby,B.R.,1980, Early Palaeozoic palaeomagnetism in South East Australia, J. Geomag. Geoelectr., 32, Sup. 3,11-21.

Irving,E.,1966, Palaeomagnetism of some Carboniferous rocks from New South Wales and its relation to geological events, J. Geol. Res., 71,6025-6051.

Klootwijk,C.T.,1985, Palaeomagnetism of the Tasman Fold Belt: Indications of Mid-Carboniferous large-scale southward displacement of the New England region, Third Circum-Pacific Terrane Conference, Geol. Soc. Australia, Abstracts, 14, 124-127.

Klootwijk,C.T.,1987, Displacements within the Tasman Fold Belt: Palaeomagnetic indications?, Proceedings Pacific Rim Congress 87, 241-243.

Klootwijk,C.T. and Giddings,J.W.,1988, An alternative APWP for the Late Palaeozoic of Australia and implications for terrane movements in the Tasman Fold Belt, 9th AGC, Abstract.

Lackie,M.A.,1988, Magnetic fabric and palaeomagnetism of the Dundee Rhyodacite and comagmatic granites of the Moonbi Suite, 9th AGC, Abstract.

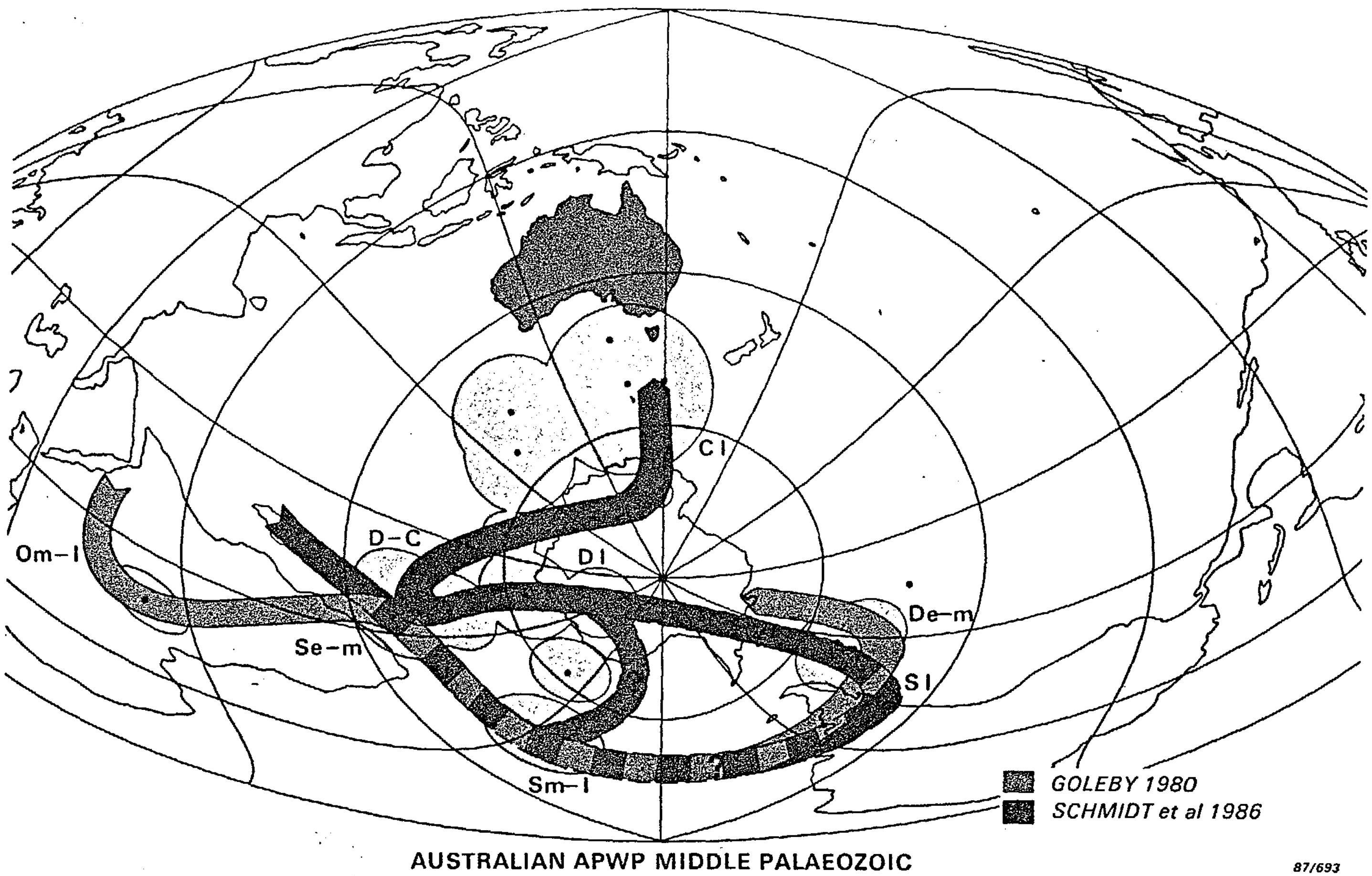
Schmidt,P.W., Cudahy,T.J., Powell,C.McA. and Embleton,B.J.J.,1986, Pre-folding and pre-megakinking magnetizations from the Devonian Comerong Volcanics, N.S.W., Australia and their bearing on the Gondwanaland Pole Path, Tectonics, 5, 135-150.

Schmidt,P.W., Embleton,B.J.J. and Palmer,H.C.,1987, Pre- and post-folding magnetizations from the Devonian Snowy River Volcanics and Buchan Caves Limestones, Victoria, Geophys. J. Roy. Astr. Soc., 91, 155-170.

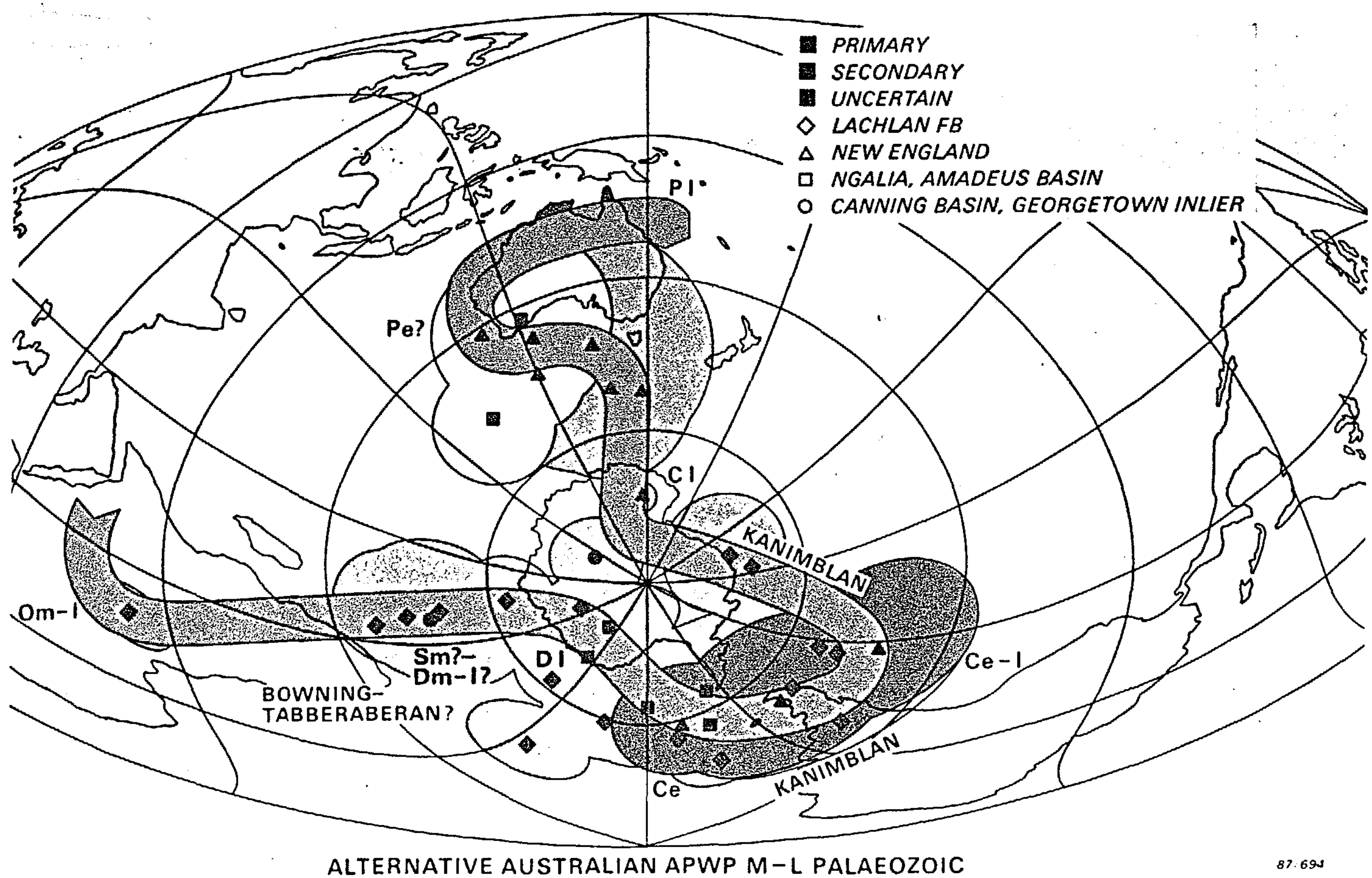
Schmidt,P.W., Current palaeomagnetic constraints on Tasman terrane analysis, 9th AGC, Abstract.

Zheng Xiang Li, 1987, New Palaeomagnetic results from Late Palaeozoic rocks of Australia and their tectonic significance, Proceedings Pacific Rim Congress 87, 267-271.

Zheng Xiang Li, Schmidt,P.W., Powell,C.McA. and Embleton,B.J.J.,1988, Pre- and syn-deformational remanent magnetizations from Mid-Palaeozoic sedimentary rocks of Australia and their tectonic implications.



Middle to Late Palaeozoic APWP for the Cowra Trough - Molong High according to Goleby (1980) and for Australia according to Schmidt et al., (1985).



Alternative Middle to Late Palaeozoic APWP for Australia according to Klootwijk (1987, 1988).

GEOTHERMAL PROFILES

J. P. Cull[1] & A. C. Cook[2]

1 - Monash University
2 - University of Wollongong

HEAT FLOW

Heat flow data can be used to provide constraints on lithosphere dynamics, basin evolution, and hydrocarbon maturation. In addition seismic velocities must be corrected for variations in temperature prior to any detailed interpretation involving geochemical anomalies and phase transformations. Unfortunately heat flow data are difficult to obtain.

Estimates of heat flow are available at 109 sites in Australia (Cull 1982). Data have been obtained mainly in holes drilled for mineral exploration; these can be preserved using a surface collar. Expensive casing is required in soft rock and consequently few holes have been secured in sedimentary basins. Only two sites (Moonie/Cabawin and Ipswich) lie within the transect (Sass 1964, Hyndman 1967); errors in each determination exceed 15% but estimates in the range 41-63 mW/m2 are consistent with regional trends.

Few corrections have been applied to the observed geothermal gradients in Eastern Australia other than rejecting shallow segments affected by climatic change. Local refraction has been identified in some holes (eg Hyndman & Sass 1964) but detailed mapping is required to establish the geometry of complex contacts. Regional perturbations complicated by groundwater flows may be even more difficult to detect. However it is significant that the lowest values of heat flow in the Proterozoic occur on the recharge margins of major aquifers.

GEOTHERMAL GRADIENTS

Estimates of heat flow can be extended using geothermal gradients measured in water bores and petroleum wells (eg Middleton 1979; Cull & Conley 1983). The data are subject to considerable error and local anomalies are difficult to detect. However statistical trends can be readily established assuming constant values for thermal conductivity.

About 4700 artesian wells have been drilled to depths as great as 2000m in the Great Australian Basin. Individual flows exceeding 10 000 m3/day have been recorded. Temperatures at the well head commonly range from 30-50 C but several produce water at 100 C. Bottom-hole temperatures have been recorded by BMR for 940 water bores. These are assumed to be in equilibrium with the adjacent aquifer and gradients can be established by comparing data from different depths at several sites in one region.

Bottom-hole temperatures are obtained as a matter of routine during the drilling of oil exploration holes. Many of these data are contained in reports available to the public. Data quality is highly variable according to logging procedure and calibration errors. In particular all measurements can be considered to represent minimum estimates. Normal geothermal gradients are modified by the circulation of drilling muds at surface temperatures and corrections are required. Both empirical and exact methods of compensation have been proposed by log analysts with reasonable success.

Errors in the raw data were recognised by Nicholas et al (1980) during compilation of a geothermal data base. However relaxation times were rarely documented and consequently no corrections were attempted. Instead relative geothermal gradients were calculated from uncorrected bottom-hole temperatures at several depths extrapolated to include the mean surface temperature. This method provides a rapid means of estimating representative gradients and broad regional trends. However absolute values may be in error by more than 20 C.

Geothermal gradients in the Cooper Basin and the overlying Eromanga Basin range from 30-60 C/km (Fig 1). High gradients (>45 C/km) occur in and around the Nappamerri and Tenappera Troughs - particularly in areas underlain by granite basement such as the Strzelecki, Moomba, and Big Lake gasfields. It is possible that high-level intrusions which are significantly enhanced in U,K, and Th are related to the anomolous heat flow exceeding basement values. The lowest temperature gradients occur in the Patchawarra Trough which is assumed to overlie a thick pre-Permian Warburton Basin section.

Few samples are available for determinations of thermal conductivity in petroleum wells. However correlations have been established with seismic velocities and estimates can be based on uniform compaction models. Adopting these techniques Middleton (1979) reports geothermal gradients close to 52 C/km for the Moomba/Big Lake region suggesting heat flow of 108 mW/m2 (100% greater than values in the east at Moonie/Cabawin).

GEOTHERMAL HISTORY - MATURATION

Heat flow in a sedimentary basin can strongly influence hydrocarbon accumulation and maturation. However organic maturity (Rank) can be determined independantly using vitrinite reflectance (VR) of the dominantly land-plant organic matter throughout the Cooper/Eromanga Basin (Kantsler et al 1983). Data are available from more than 90 wells providing good control in the southern basin but a lesser degree of control in the northern basin. For each well 5-35 samples were examined over the entire section allowing an examination of the geothermal history.

Variations in rank for the southern Cooper Basin are strongly influenced by high palaeo-heatflow in the Nappamerri Trough causing a maturity high which persists into the lower Cretaceous section. In particular a palaeo-heatflow higher than present values is required to model maturation in the Big Lake-Moomba area.

A Permian to Late Triassic phase of high heat flow is considered likely because of offsets and changes in gradient on plots of VR against depth at or near the Jurassic/Triassic unconformity throughout the Basin. These data also imply significant (>500 m) erosion in the Late Triassic. High initial heat flow may be related to deep crustal metamorphism and/or crustal extension associated with basin formation.

Outside the Nappamerri Trough maturation of the Permian section can generally be modelled within the constraints of the present-day thermal regime. However there is an overestimate of maturation in some cases if the geothermal gradient is extrapolated to the Jurassic/Cretaceous. This indicates a late rise in temperature, variations in geothermal gradient with depth, or errors in bottom-hole temperature data.

COMMENT

Additional heat flow data will be difficult to accumulate other than on an opportunity basis in holes drilled for other purposes. Consequently more detailed geothermal modelling will require secondary constraints possibly based on VR studies and silica geochemistry. In addition there is some prospect that aeromagnetic data can be manipulated to provide an indication of variations in the Curie depth. Similarly resistivity profiles obtained from magnetotelluric data may be related to the geothermal gradient.

There are sufficient observations to construct a limited burial history for major basin units and to provide representative geothermal gradients for the lower crust. Modifications are required to incorporate anomalies related to regional refraction at basin margins and to account for groundwater migration.

SELECTED BIBLIOGRAPHY

Cull, J.P.,1982. An appraisal of Australian heat flow data. BMR Journal of Aust. Geol. & Geophys., 7, 11-21.

Cull, J.P., and Conley, D., 1983. Geothermal gradients and heat flow in Australian sedimentary basins. BMR Journal of Aust. Geol. & Geophys., 8, 329-337.

Cook, A.C.,1986. The nature and significance of the organic facies in the Eromanga Basin. In Gravestock,D.I., Moore,P.S., & Pitt,G.M.,(eds),Contributions to the geology and hydrocarbon potential of the Eromanga Basin, Geol.Soc.Aust., Spec.Publ., 12, 255-266.

Hyndman,R.D., and Sass,J.H., 1966. Geothermal measurements at Mount Isa Queensland. Journal of Geophys. Res., 71, 587-601.

Hyndman,R.D., 1967. Heat flow in Queensland and Northern Territory Australia. Journal of Geophys. Res., 72, 527-539.

Kantsler, A.J., Prudence, T.J.C., Cook, A.C., and Zwigulis, M., 1983. Hydrocarbon habitat of the Cooper/Eromanga basin, Australia. APEA Journal, 23, 75-92.

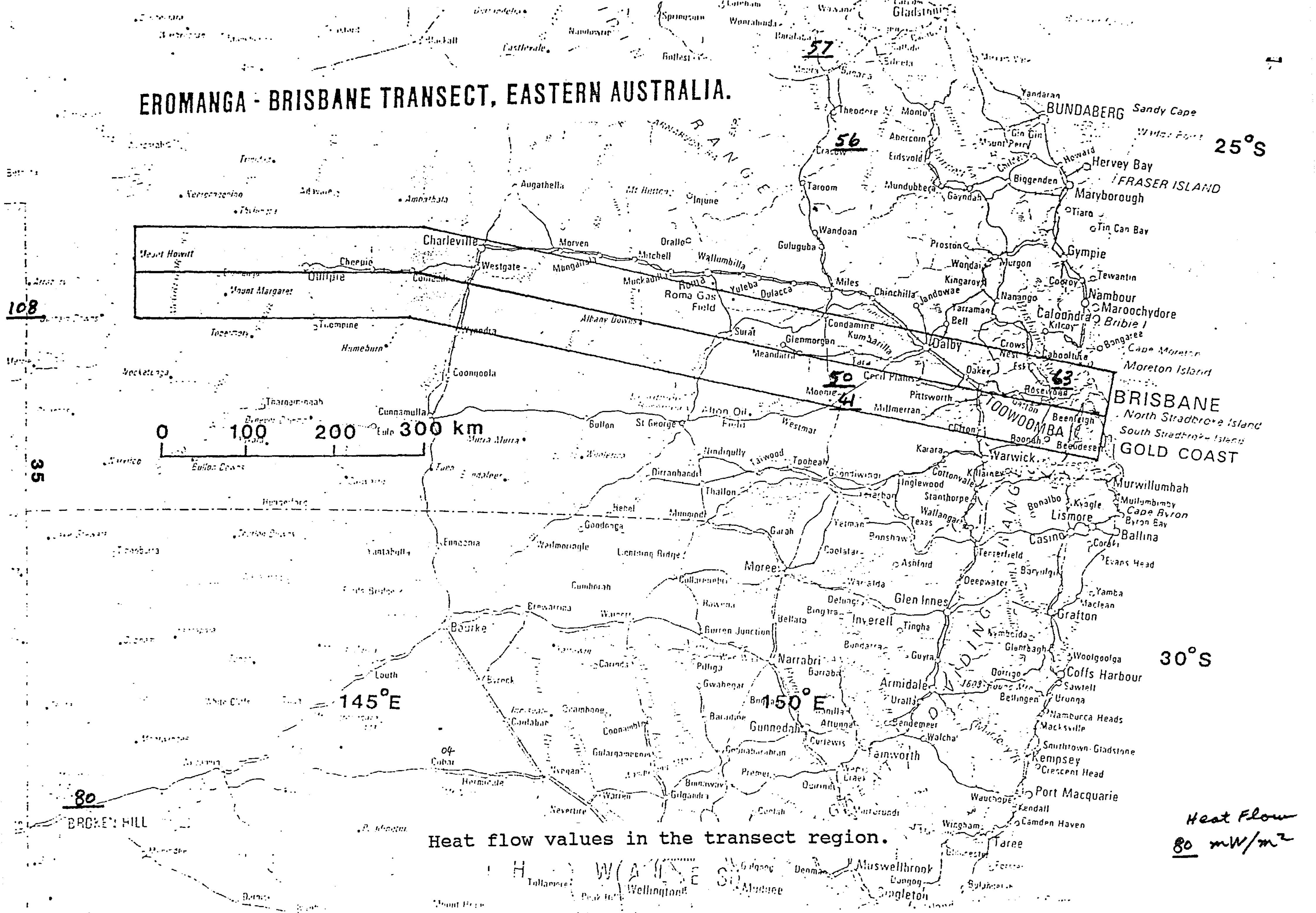
Middleton, M.F., 1979. Heat flow in the Moomba, Big Lake, and Toolachee gas fields of the Cooper Basin and implications for hydrocarbon maturation. Bull. Aust. Soc. Explor. Geophys., 10, 149-155.

Nicholas,E.,Rixon,K.,and Haupt,A.,1980. Uncorrected geothermal map of Australia. BMR Australia Record 1977/17.

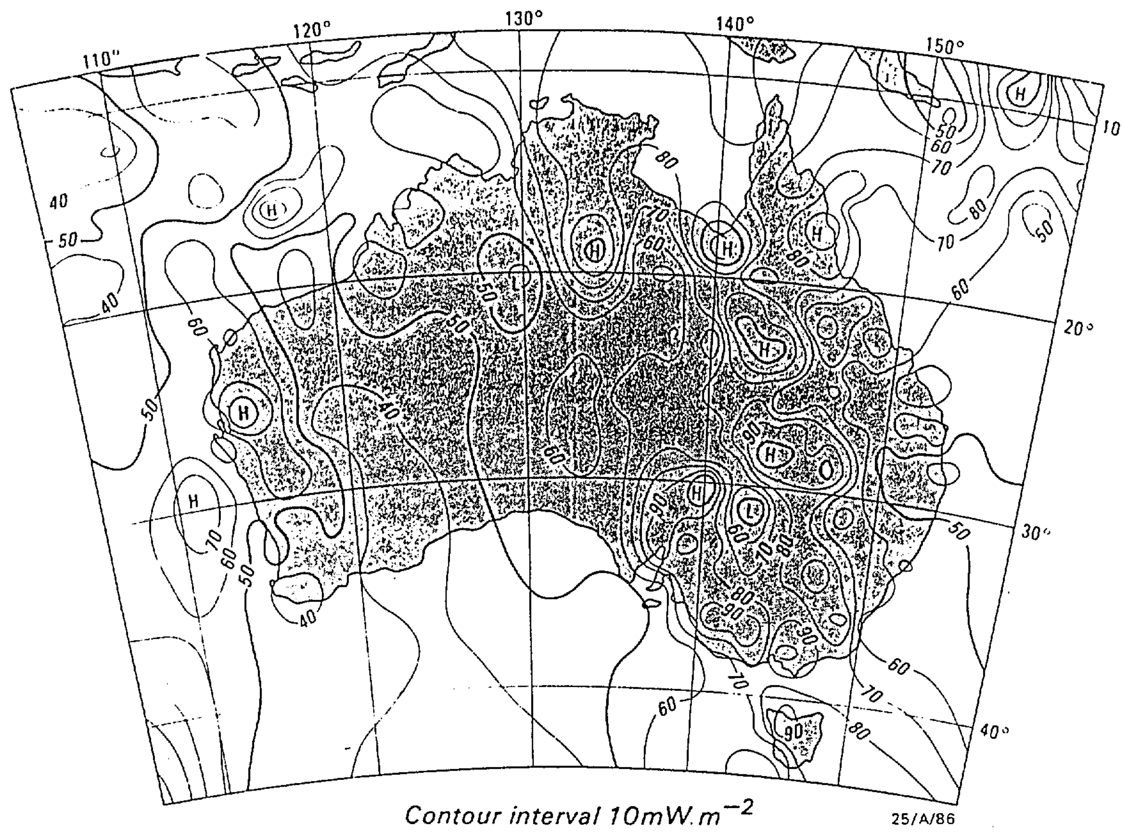
Polak,E.J.,and Horsfall,C.L.,1979. Geothermal gradients in the Great Artesian Basin Australia. Bull.Aust.Soc.Explor. Geophys., 10, 144-147.

Sass,J.H., 1964. Heat flow values from Eastern Australia. Journal of Geophys. Res., 69, 3889-3893.

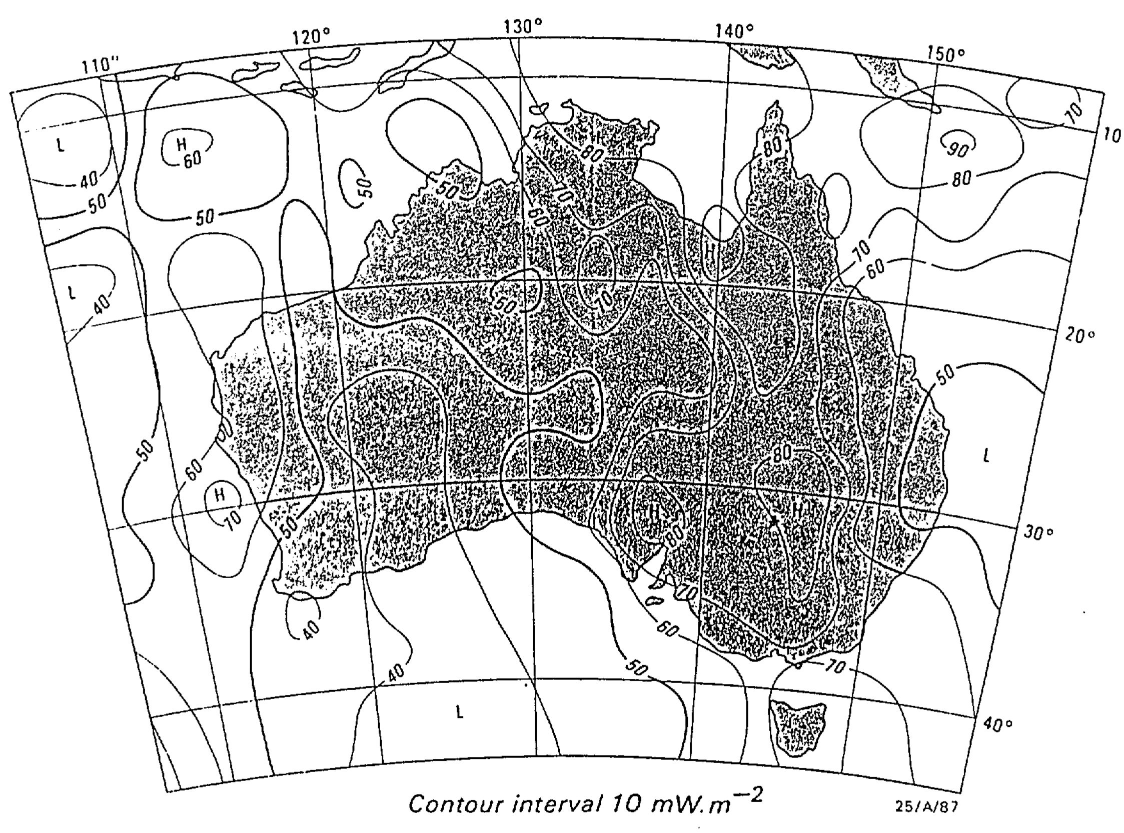
EROMANGA - BRISBANE TRANSECT, EASTERN AUSTRALIA.



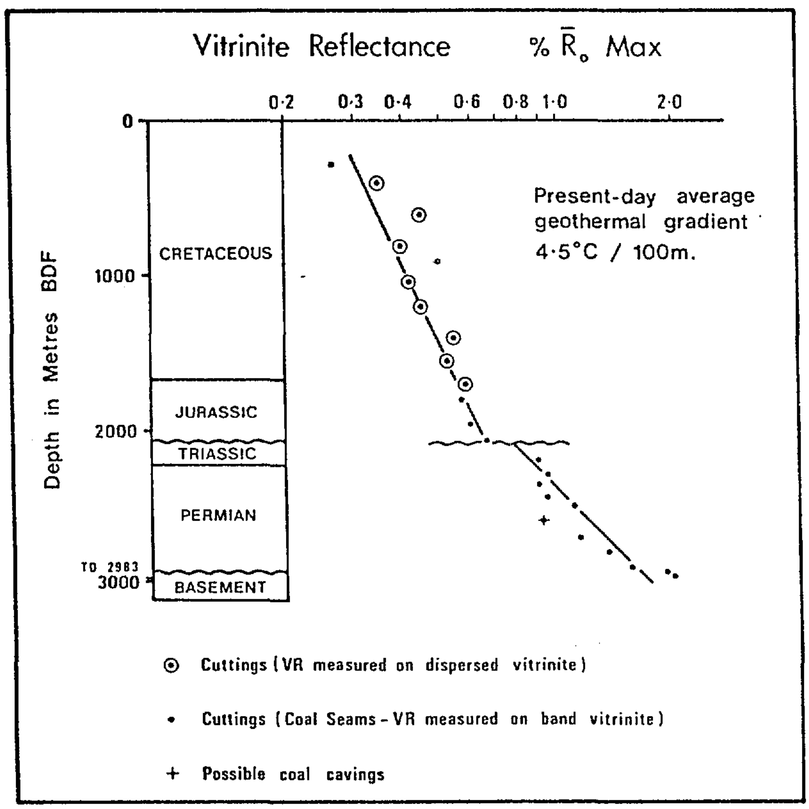
Heat flow values in the transect region.



Estimated heat flow, based on transformation of the geothermal gradients
Marine data from Cull (1982). Contours based on averages over a 1° grid.



Heat flow contours based on averages over a 3° grid.



— Depth *vs* reflectance profile for Yalcumma-1 well, southern Nappamerri Trough.

NEW ENGLAND OROGEN: STRUCTURE AND TECTONICS

R. J. Korsch[1], H. J. Harrington[1], C. L. Fergusson[2],
P. G. Flood[3], J. Aitchison[3], & C. G. Murray[4].

1 - Bureau of Mineral Resources, Geology and Geophysics, Canberra.
2 - University of Wollongong.
3 - University of New England, Armidale.
4 - Queensland Department of Mines, Brisbane.

1. Accretionary Wedge Model

There now seems to be a consensus among most geologists working in New England that during the Devonian and Carboniferous the southern New England Orogen developed at a convergent plate margin related to a west dipping subduction zone. In the east the Tablelands Complex (Zone B) is interpreted as an accretionary wedge that grew oceanwards by accreting trench-fill volcaniclastic turbidites (derived from a magmatic arc) and minor amounts of oceanic crust (basalt, chert, pelagic mudstone). Timing of the deformation(s) of the accretionary wedge is poorly constrained but if the model is correct then the deformation should be diachronous and also migrate oceanwards with time.

To the west of the accretionary wedge, the Tamworth Belt (Zone A) is interpreted as a fore-arc basin. The volcanic arc, although now not exposed except for minor breccias in the Devonian and felsic volcanic centres near Boggabri and Gunnedah and in the Carboniferous of the Hunter Valley, is inferred to have been located to the west of the Tamworth Belt.

In the northern New England Orogen, the tripartite subdivision of the Devonian-Carboniferous arc-forearc assemblage is well developed and consists of: the Connors and Auburn arches in the west (magmatic arc), the Yarrol Belt in the centre (forearc basin) and the Coastal Block and its southern equivalents in the east (accretionary wedge).

Problems:

1. What is the age of formation of the accretionary wedge (this is currently being addressed in part by studies of radiolarians that have recently commenced, and which will define the time of deposition of the oceanic sediments and provide a maximum for the age of accretion) ?

2. Can we document the deformations (both syn- and post-accretion) and constrain their ages in the accretionary wedge ?

3. What is the cause of the anomalous width of the interpreted accretionary wedge relative to contemporary analogues ?

4. Is the accretionary wedge a single unit or a collage of terranes ?

5. What is the relationship between the accretionary wedge and fore-arc basin and what is the nature and history of the boundary between them (now the site of the Peel Fault) ?

6. Where is the volcanic arc which should be west of the Tamworth Belt ? (e.g. buried beneath the Sydney-Gunnedah Basin, removed by erosion, transported elsewhere by strike-slip faulting etc.).

7. Is the geochemistry of the volcanics in the Connors and Auburn arches consistent with a subduction-related origin ? Does the geochemistry indicate arc polarity ? Are the volcanics comagmatic with the Late Carboniferous granites that intrude them ?

2. Oroclinal Bending

There also seems to be a consensus among most workers in recognising that the northern part of the accretionary wedge in New England has been involved in oroclinal bending which has produced the mega-folds in the Texas and Coffs Harbour areas and possibly elsewhere, and has led to a widening of the orogen in this area and apparent repetition of some internal elements.

Problems:

1. Does the orocline really exist ?
2. Timing of formation of the orocline (e.g. Late Carboniferous c. 300 Ma or Early to Mid Permian c. 280-265 Ma).
2. What rocks have been involved in the bending (e.g. have fore-arc basin rocks been involved) ?
3. What is the relationship of the orocline to Early Permian fault basins in the Texas area and to younger sedimentary basins such as the Clarence-Moreton Basin ?
4. What is the mechanism of formation of the orocline ?

3. Terrane Recognition

There is less consensus on the recognition and definition of terranes in the orogen. Several different schemes have been proposed and the most consensus occurs on the Gympie terrane which is considered to be an allochthonous, displaced or exotic terrane. In fact the Gympie terrane (? terranes) is the best candidate for a terrane which could be regarded as being allochthonous to New England and it has been inferred by some to be related to rocks of the same age in New Zealand. Other possible terranes are the Beenleigh Block, the Shoalwater Formation, and the Middle Carboniferous limestone at Murgon.

Problems:

1. Agreement on recognition of terranes (cf. Coney et al. ?). Should the accretionary wedge be divided into separate terranes ? Should the fore-arc basin and accretionary wedge be linked as a pair that formed in juxtaposition ?

2. How do the compositionally different Beenleigh Block and Shoalwater Formation (?terranes) relate to the rest of the accretionary wedge in New England ? Could they represent exotic terranes ?

3. Does the Calliope Island Arc represent an exotic terrane which docked at the end of the Middle Devonian ?

3. What are the boundaries to the Gympie terrane ? Could it comprise more than one terrane ? What is/are the time/s of arrival and docking of the Gympie terrane/s ? What geological effects did this have on the rest of New England ?

4. What is the relationship of the Hastings Block to the Tamworth Belt and Nambucca slate belt ?

4. Tectonic Significance of the Granites

The New England Orogen is unusual in that it contains a significant (enormous) volume of granitoid plutons and related volcanics in comparison with other ancient accretionary wedges (e.g. Franciscan, Torlesse). Both S-type and I-type plutons have been described and these have been divided into several suites and/or belts. Although the I-type plutonism is probably related to a calcalkaline magmatic arc, there has been no satisfactory explanation as to how the plutonics relate to the overall tectonic development of the orogen.

Problems:

1. Why are the S-type plutons older than and geographically separated from the I-type plutons ?
2. What has caused the intense deformation of the Hillgrove suite but not any of the other suites ?
3. What is the nature of the events that caused the emplacement of the plutons and associated thermal metamorphism into the accretionary wedge (normally a low heat flow area) ?
4. Is the emplacement of the plutons related to the cessation of subduction and/or plate reorganisation ?
5. Why are plutons abundant in the accretionary wedge but rarer in the forearc basin (i.e. what are the differences in the lower crust and upper mantle between these two regions) ?
6. How do the plutons relate to the oroclinal bending (i.e. some are earlier and some are later than the bending) ?

5. Post-accretion Sedimentation and Deformation

Large areas of New England consist of deep-water marine diamictites and fine-grained sediments that contain Permian fossils. These rocks are usually intensely deformed and in places such as the Nambucca slate belt are among the most severely deformed rocks that occur in the orogen. This deformation also occurred in the Permian because the rocks are then intruded by post-orogenic late Permian to Triassic plutons and overlain by Middle Triassic basin sediments that are essentially undeformed. This deformation probably affected most of New England.

Problems:

1. What mechanism led to development of the sedimentary basins in which the sediments were deposited ?

2. What caused the deformation to follow closely after sedimentation ?

3. What was the role of strike-slip faulting in the Permian (and also earlier during formation of the accretionary wedge), and in the Triassic (e.g. movement on the Demon Fault and North Pine Fault) ?

Work Required:

The whole of the New England Orogen requires:

1. Detailed mapping at 1:5000 to 1:25000.
2. Palaeontology, particularly radiolarian biostratigraphy.
3. Isotopic dating, particularly U-Pb zircon work.
4. Palaeomagnetism.
5. Structural-tectonic analysis based on 1-4.

Work in similar areas overseas has clearly demonstrated the necessity for detailed mapping, but because this is time consuming it is unlikely that much will be done before the completion of the work on the transect.

CLARENCE-MORETON BASIN DEPOSITIONAL AND STRUCTURAL HISTORY

P. E. O'Brien & A. T. Wells
Bureau of Mineral Resources, Geology and Geophysics, Canberra.

Introduction

In this position paper we shall concentrate on research in the Clarence-Moreton and associated basins that impinges on the tectonics of the region, therefore some work on sedimentology, stratigraphy, biostratigraphy and organic geochemistry will be mentioned only briefly. Much of the work reviewed is either in progress, in press or being written up so that the bibliography is not extensive. Also this review is biased somewhat towards the joint B.M.R.- state surveys Clarence-Moreton Basin Project because of our first hand knowledge of that work.

In considering the Clarence-Moreton Basin part of the transect, other basins beneath the Clarence-Moreton need to be included. These are the Ipswich Basin, Esk Trough, Tarong Basin and unamed sequences beneath the Esk Trough and the eastern Clarence-Moreton Basin.

Basin Structure

The major structures of the Clarence-Moreton Basin are north-north-west to north-north-east trending sub-basins separated by structural highs. Korsch et al. (in press) interpret the basin geometry revealed on BMR Traverse 16 as indicating the following history of basin formation:-

1. Transtension on the West Ipswich fault during the Late Permian to Early Triassic formed a pull apart basin on the western side of the fault.

2. Thermal relaxation and continued movement on the fault resulted in deposition of the sediments in the Esk Trough and Clarence-Moreton Basin.

3. After the initial pull apart formed on the western side of the West Ipswich Fault, the locus of movement stepped eastward along the line of the present Laidley Sub-basin. We interpret the Chillingham Volcanics and possibly the Nymboida Coal Measures as part of the initial pull-apart basin fill in the east and that the Ipswich Coal Measures and Clarence-Moreton sediments were deposited during thermal relaxation.

We interpret the South Moreton Anticline - Richmond Range Horst as a major strike-slip fault zone. Folds on the crest of this structure indicate continued dextral movement during and after deposition of the Clarence-Moreton Basin.

Problems: The interpretation above needs to be tested and refined primarily by better mapping and dating of the sequences seen beneath the eastern Clarence-Moreton on company seismic. At present, the relationship of the sequences seen on seismic to the Nymboida Coal Measures is unclear. When their geometry and age is determined, a more comprehensive model of basin formation can be developed.

Stratigraphy and Sedimentology

Clarence-Moreton: A major revision of the basin stratigraphy is nearly complete (Wells et al., in prep.). It provides a scheme applicable to both New south Wales and Queensland parts of the basin and which reflects major depositional events. Palaeocurrent, sandstone petrology and sedimentological studies of the Bundamba Group indicate which sedimentation changes were caused by uplift of basin margins and which ones had other causes. Palaeocurrent studies also indicate that the fluvial systems that deposited the Bundamba Group flowed northwards, out of the basin. The absence of Jurassic sediments north of the present basin margin suggests differences in post-Jurassic uplift history between the area north of Brisbane and the Clarence-Moreton Basin area to the south.

The Walloon Coal Measures are an important yet poorly understood unit in the Clarence-Moreton Basin. Their volcanolithic composition indicates major volcanism, presumably to the east, which must reflect major tectonic changes on the eastern continental margin at the time. Work on the depositional style of the unit is proceeding (Fielding,1988) but some investigation of the nature of the volcanism based on the detritus would be valuable in inferring Jurassic events to the east of the present continent.

Ipswich Coal Measures: Sedimentological work on the Ipswich Coal Measures is proceeding (Falkner,1986a,b; 1988) along with studies of equivalent sediment in the Tarong Basin (Flood & Garces, 1986a,b) and Red Cliff Coal Measures (O'Brien et al., in prep.). Flood & Garces (1986) interpret the Tarong Basin as a pull apart basin on a strike slip fault system. Further work on the geometry and subsurface facies of the Ipswich Coal Measures is required because almost all studies of these rocks have concentrated on the Ipswich area which may be tectonically anomalous. The Ipswich area flanks the West Ipswich or Great Moreton Fault zone, which a major strike-slip fault zone (Korsch et al., in prep.) and thus may have a history dominated by movement on this fault and quite different to other areas beneath the Clarence-Moreton Basin.

Older Sequences: Work on the sequence beneath the Ipswich Coal Measures in the Laidley Sub-basin has so far consisted of attempts to map their geometry on company seismic data. There is a need to establish the age of both the Nymboida Coal Measures and the base of the Chillingham Volcanics.

Burial and Uplift History

Subsidence curves for the different parts of the Clarence-Moreton Basin have been constructed using existing biostratigraphic and geochronological data but these are not well enough constrained at present to allow back stripping (Korsch et al., in press). The broad shape of these curves supports the basin model set out in Korsch et al.(in press).

Vitrinite Reflectance and Fission track data gathered in the course of the study of the hydrocarbon source potential indicates rapid Late Cretaceous uplift of the eastern part of the basin. The amount of uplift is in the order of 2km near the coast and reduces to around 800m in the west near Cecil Plains. This uplift was probably associated with rifting prior to opening of the Coral Sea.

REFERENCES

FALKNER, A.J., 1986a - A facies model of the Blackstone Formation: Upper Triassic of the Ipswich Basin. 12th International Sedimentological Congress, Canberra Australia, Abstracts, p.100.

FALKNER, A.J., 1986b - An alternative method of palaeoenvironmental analysis of coal seams. 12th International Sedimentological Congress, Canberra Australia, Abstracts, p.100.

FALKNER, A.J., 1988. Sedimentology of the Brassell Subgroup: a comparison of sandstone and mudstone dominated coal measure sequences. 9th Australian Geological Convention.

FIELDING, C.R., 1988 - Sedimentary environments of the mid Jurassic Walloon Coal Measures in the Rosewood - Walloon coalfield, SE Queensland. 9th Australian Geological Convention.

FLOOD, P.G. & GARCES, B. Jun., 1986a - Tectonic/sedimentologic control of peat/ coal accumulation in the Late Triassic strike-slip (pull-apart) Tarong Basin, Queensland, Australia. 12th International Sedimentological Congress, Canberra Australia, Abstracts, p.108.

FLOOD, P.G. & GARCES, B. Jun., 1986b - The Tarong Basin, Queensland. In: Willmott, W.F., editor, Field guide to the South Burnett district (Field Conference, 1986), Geological Society of Australia, Queensland Branch, pages 77-81.

KORSCH, R.J., O'BRIEN, P.E., SEXTON, M.J., WAKE-DYSTER, K.D., & WELLS, A.T., in prep. Development of Mesozoic transtensional basins in easternmost Australia. Submitted to Australian Journal of Earth Sciences.

O'BRIEN, P.E., WELLS, A.T., SMYTH, M. & RUSSELL, N.J., in prep. Alluvial fan and floodbasin sedimentation in the Red Cliff Coal Measures, New South Wales, Australia. Submitted to Australian Journal of Earth Sciences.

WELLS, A.T., O'BRIEN, P.E., WILLIS, I.L. & CRANFIELD, L.C., in prep. A new stratigraphic framework for the Early Jurassic lithostratigraphic units in the Bundamba Group, Clarence-Moreton Basin, Queensland and New South Wales.

THE SURAT BASIN AND UNDERLYING BASINS

C. R. Fielding
University of Queensland.

Introduction

This position paper aims to summarise knowledge on the geology of the Surat Basin area, discuss sources of data and offer a strategy for synthesising that data in a form which is compatible with the BMR deep seismic traverse. The resulting compilation may then be used to interpret features noted on deep reflection profiles and hopefully provide an understanding of crustal structure over the area. For the purposes of this paper, the Surat Basin area is defined as that region east of the Nebine Ridge and west of the Kumbarilla Ridge structural features (Fig.1).

Geological History

The area was a site of accumulation of major volumes of sediment during Permian to Cretaceous times (the Bowen and Surat basin fills) and lesser amounts of sediments and volcanics during Tertiary and Quaternary times. A variety of pre-Permian (basement) rock types are known across the region.

Geological data acquired pre-1975 were synthesised and interpreted by Exon (1976), whose work still constitutes the state-of-the-art. More recently exploration company and government personnel have contributed further to knowledge on the area.

Rocks of Devonian to Early Triassic age constitute "economic basement" across the area. These are of various types, notably sedimentary rocks (Texas Beds, Yarrol Basin sequence) metasediments ("Timbury Hills Formation") and intrusive igneous bodies (Roma Granites, Auburn Complex, Yarraman Complex, Texas Granite, etc.) Distribution of the various units is shown by Exon (1976).

Unconformably overlying these rocks are the volcanic and sedimentary rocks of the Bowen basin fill. These range in age from Early Permian to Middle Triassic in age, the oldest being volcanics and associated sedimentary rocks of the "Kuttung Formation". All major stratigraphic units of the Bowen Basin fill defined at outcrop are known from the subsurface, and are considered to be continuations of the Denison Trough and Taroom Trough depocentres.

Following a period of non-deposition during Late Triassic times, the Surat basin sequence was deposited. Sediment accumulation was more or less continuous from Early Jurassic until mid Createaceous times. The Late Cretaceous and Early Tertiary was a time of uplift and erosion, the Mid Tertiary characterised by widespread volcanism, hence further erosion and ultimately further sediment accumulation in the Recent.

Concerning the structural development of the area, there are varying degrees of consensus for the different sequences. Mid Palaeozoic rocks were metamorphosed and intruded during the carboniferous Kanimblan Orogeny. Development of the Bowen Basin began in the Latest Carboniferous/Early Permian as a graben/half-graben complex in the west (the Denison Trough). Later, the axis of subsidence moved eastward as the Taroom Trough began to rapidly subside.

There is disagreement over the mechanism by which the Bowen Basin was formed. The traditional view, held by Elliott & Brown (1988), is that the Basin is of "foreland" type, formed in the back-arc region of a continent-ocean collision zone. This has recently been challenged by Hammond and Mallett (1988), who contend that structural and other data argue for an extensional origin. Whatever the process responsible for the opening of the Bowen Basin, there is no controversy over the notion of a Late Triassic period of compressive structural deformation which folded and faulted the sequence, reactivating and reversing earlier faults.

The Surat Basin appears to have formed in a more passive manner than the underlying Bowen. As with earlier events, the structural trends controlling the development of the Basin were dominantly north-south-trending, but in the case of the Surat subsidence was accommodated dominantly by passive downwarping.

Latest Mesozoic and Tertiary events are considered to be related to the opening of the Tasman Sea. In the Recent, glacio-eustatic events have controlled patterns of sediment transport and accumulation.

Sources of data

Geological information from a variety of sources will be utilised during the present project. A comprehensive stratigraphic framework has been established for the Surat and much of the Bowen Basin fill, perhaps less so for the underlying "basement" units. Generalised sedimentological information has been published on most of the intervals of concern, again somewhat lacking for the older sequences.

Structural data, critical to the interpretation of the deep seismic traverse, are scattered. Various exploration companies have detailed compilations of structural trends over ATP's in which they have interests. Government organisations (BMR, GSQ, CSIRO) have more generalised compilations over larger areas. To the author's knowledge, however, there is as yet no comprehensive map of structural trends over the entire area.

Strategy

The ultimate aim of the project is to provide a defendable interpretation of crustal structure across the BMR deep seismic traverse. To achieve this aim, the various structural, stratigraphic and sedimentological data mentioned above must be assembled and critically evaluated. Features visible on the deep seismic reflection records may then be interpreted in the light of whatever conclusions are drawn from the compilation.

I perceive the main tasks initially to be:-

1. preparation of structural trend maps and basement maps by combining data from various sources onto standardised 1:1,000,000 scale base-maps. This may be achieved by an iterative process of regular communication between participants . Participation by exploration companies has been promised.

2. compilation of this and other geological data into a series of geological models for the evolution of the Surat area.

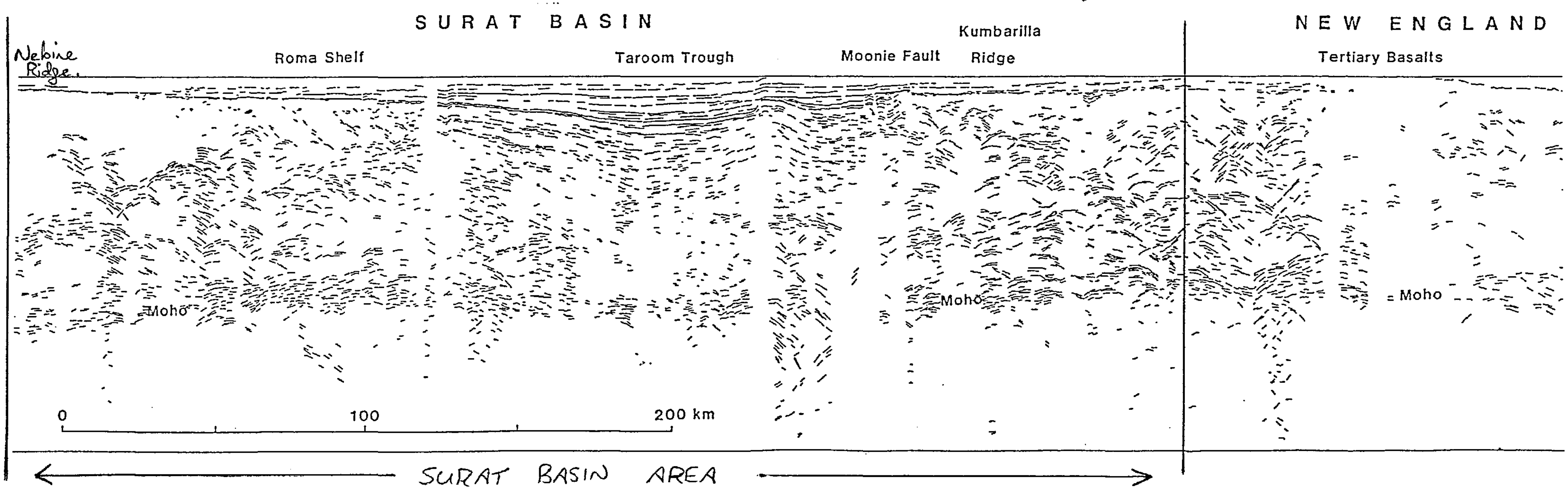
Stage 2 should be completed by about September 1988 to allow the final interpretation of the deep reflection data and preparation of a final report by end-1988.

References

Elliott, L.G. & Brown, R.S. 1988. The Surat and Bowen Basins. In: APEA Journal, Bicentennial Volume, in press.

Exon, N.F. 1976. Geology of the Surat Basin in Queensland. BMR Bulletin 166, 2 Vols.

Hammond, R.L. & Mallett, C.W. 1988. The Bowen Basin - an upper crustal extension model for its formation. In: Geological Society of Australia Abstracts 21, (9th Australian Geological Convention), 168-169.



Definition of the Surat Basin region crossed by deep seismic reflection profile.