BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD

RECORD No. 1983/20

Australian National Report

to the

International Association of

Seismology and Physics of the Earth's Interior
1979-1982
compiled by

D. Denham.

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PREFACE

This report covers the main solid-earth geophysical activities of interest to IASPEI that have been carried out in Australia since the 1979 IUGG Assembly. It has been prepared at the instigation of the Australian Academy of Science's Sub-Committee on Seismology and Physics of the Earth's Interior and will be presented at the 18th General Assembly of the IUGG at Hamburg.

It is hoped that the report will not only provide an overview of Australian activities in solid-earth geophysics to the international Hamburg meeting but will also provide a useful compendium of material for Australian earth scientists.

I would like to thank those who contributed material to make this report possible.

David Denham
(Compiler and Chairman
of SPEI Sub-Committee)

CONTENTS

INTRODUCTION

The decision to produce this compilation of earth science research activities arose from a meeting of the Australian Academy of Science's Sub-Committee for Seismology and Physics of the Earth's Interior (SPEI) which was held in February 1982. Because the solid earth parts of the International Association of Geomagnetism and Aeronomy as well as the IASPEI disciplines are covered by the SPEI Sub-Committee the main topics listed include:

earthquake seismology

explosion seismology

geothermal studies

physical properties of the Earth's interior

palaeomagnetism and

geomagnetism

Feed-back to the SPEI committee on the value of this document will be welcome so that any future reports of this type can better meet the requirements of the Australian earth science community.

CONTRIBUTORS

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Research interests and programs

Structure of the descending lithosphere beneath the Tonga Island Arc.

Earthquake focal mechanisms

Attenuation of short-period body waves in the Earth's mantle.

Reservoir-induced seismicity.

Summary of research work since 1978

Structure of the descending lithosphere

P-wave travel-time residuals at the Warramunga Seismic Array (WRA) have been studied from 49 earthquakes with epicenters south of 19°S in the Fiji-Tonga region. Focal depths are between 42 and 679 km as determined from pP-P times. Using the Jeffreys-Bullen and the Herrin travel time tables, the epicentral parameters have been redetermined by considering only "normal" seismic stations in the location procedure; that is, those stations where P-wave travel-times are unlikely to be affected by lateral heterogeneities caused by the lithosphere descending beneath the Tonga trench. The resulting pattern of P-residuals at WRA does not show any significant change with depth below 350 km. The residuals become more negative for shallower earthquakes above about 250 km. P-waves to WRA are advanced by approximately 2 seconds compared with those from deep earthquakes. The results do not essentially differ for the two different travel time tables used. The observations can be interpreted by P-wave velocities that

are higher in the sinking slab down to 350-400 km by (5±2)% than in both the Jeffreys-Bullen and in the Herrin model. Without considering possible elevations of phase boundaries, this estimate yields a temperature difference of 1000±450°C between slab and normal mantle material in this depth range.

Earthquake focal mechanisms

An M_b = 5.9 earthquake occurred on 11 May, 1976, at 51.60°S, 139.76°E in the eastern part of the SE Indian Ocean Ridge system. It was strong enough to obtain a reliable fault-plane solution using mainly long-period seismograms from the WWSS network. The focal mechanism has been determined to be strike slip with a component of thrust faulting. The nodal planes strike about N-S and E-W. From the distribution of surrounding epicentres, the N-S striking plane is favoured to be the rupture plane. In this case the slip motion is of sinistral shear. The sense of the slip is opposite to the offset of the crest of the ridge system which agrees well with the predicted motion for transform faults. It does not, however, support the idea of an extension of this particular fracture zone towards the seismically active zone in South Australia as postulated by Cleary and Simpson (1971). If their interpretation was correct, the sense of motion should follow the offset of the ridge axis, which is not observed.

Attenuation in the Earth's Mantle

The parameter t* (= ratio of body wave travel time to the average quality factor Q) has been estimated for short-period P, PcP and ScP phases originating from earthquakes in the Fiji-Tonga region and recorded at the Warramunga Seismic Array at Tennant Creek (N.T., Australia). Spectral ratios were calculated for the amplitudes of PcP to P and of pP to P. The data reveal a laterally varying

Q-structure in the Fiji-Tonga region. The high-Q lithosphere descending beneath the Tonga Island arc is overlain above 350 km depth by a wedge-like zone of high attenuation with an average Q between 120 and 200 at short periods. The upper mantle farther to the west of the Tonga island arc is less attenuating, with Q between 370 and 560. Q is about 500 in the upper mantle on the oceanic side of the subduction zone.

Reservoir-induced seismicity

Several large reservoirs in the European Alps and in the Romanian Carpathians were monitored by high-gain seismic stations operated by the Geophysical Institute of Karlsruhe University, F.R. Germany. Over a period of 6 years, numerous microearthquakes with magnitudes less than zero were recorded that showed a clear correlation with variations of the water level. The daily and seasonal distribution of the seismic activity indicates temperature variations taking place in the rock very close to the surface as the main triggering mechanism.

Publications since 1978

FUCHS, K., BONJER, K.P., BOCK, G., et al., 1979: The Romanian earthquake of March 4, 1977, II. aftershocks and migration of seismic activity. Tectonophysics, 53, 225-247.

BOCK, G., 1980. Load-induced stresses and their relation to the initial stress field. J. Geophys., 48, 94-100.

BOCK, G. & MAYER-ROSA, D., 1980. Seismic observations at Lake Emosson, Switzerland, Pure & applied Geophysics, 119, 185-195.

MERKLER, G., BOCK, G. & FUCHS, K., 1981. Correlation between seismic microactivity, temperature and subsidence of water level at reservoirs, J. Geophys., 49, 198-206.

BOCK, G., 1981: The effect of the descending lithosphere beneath the Tonga island arc on P-wave travel-time residuals at the Warramunga Seismic Array. Phys. Earth Planet. Inter., 25, 360-371.

BOCK, G., 1981: Focal mechanism of an earthquake from the Southern Ocean. Tectonophysics, 79, T37-41.

BOCK, G. & CLEMENTS, J.R., 1982: Attenuation of short-period P, PcP, ScP and pP waves in the Earth's mantle. J. Geophys. Res., 87, 3905-3918.

DENHAM, D., BOCK, G. & SMITH, R.S., 1982: The Appin (New South Wales) Earthquake of 15 November 1981. BMR J. Aust. Geol. & Geophys., 7, 219-223.

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Research interests and programs

Palaeomagnetism

Geomagnetic Deep Sounding (Geomagnetism)

Summary of research work since 1978

Palaeomagnetism

The main palaeomagnetic research effort has been directed towards a survey of the islands of Timor and Sumba in the Banda Arc, the objective being to construct polarwander curves and to reconstruct the palaeogeography of the islands relative to Australia and South East Asia. Results to date suggest that Timor was part of the Australian continental mass since the Permian, but several formations show large local tectonic rotation. The upper Cretaceous to Recent polar wander curve for Sumba, does not fit either the Australian or South East Asian curves and suggests that the island was an independent continental fragment.

Geomagnetism

Since 1972 a digital microprocessor-based three-component fluxgate magnetometer has been developed for geomagnetic deep sounding studies. Twenty five magnetometers have been constructed and array studies have been carried out in West Java and Eyre Peninsula. The preliminary interpretation of the West Java experiment suggests a surprisingly rapid change in the vertical variation field across Java. This suggests a highly conducting zone close to the surface.

Publications since 1978

CHAMALAUN, F.H., GRADY, A.E., VON DER BORCH, C. & HARTONO, H.M.S., 1981: The teconic significance of Sumba. Bull. Geol. Res. and Dev. Center, 5, 1-20.

ABBOTT, M. & CHAMALAUN, F.H., 1981: Geochronology of some Banda Arc Volcanis. Geol. Res. Dev. Center, Spec. Publ. 2, 253-268.

J.R. Cleary (now deceased)

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Research interests and programs

Earthquake seismology

Publications since 1978

WANG, C., CLEARY, J.R. & ANDERSSEN, R.S., 1978: Ray mode duality for SH waves in Earth models with crust and mantle discontinuities - 1. The case of one discontinuity. Geophys.J.R.astr. Soc., 54, 297-308.

CHANG, A.C. & CLEARY, J.R., 1978: Precursors to PKKP. Bull. Seismol. Soc. Amer., 68, 1059-1079.

LOCK, J.M. & CLEARY, J.R., 1978: Precursors to PKIKP: An Earth model discriminant. Carnegie Inst. Wash. Year Book, 77.

CLEARY, J.R. & ANDERSSEN, R.S., 1979; Seismology and the internal structure of the Earth, In: The Earth, Its Origin, Structure and Evolution, ed. M.W. McElhinny, Academic Press, London, 137-179.

WANG, C., CLEARY, J.R. & ANDERSSEN, R.S., 1979: The effect of Earth structure on radial oscillations. J. Geophys.,45, 129-145.

ANDERSSEN, R.S. & CLEARY, J.R., 1980: Estimation of PKP times from ISC data. Phys. Earth Planet. Inter., 23, 207-214.

CLEARY, J.R., 1981: Seismic wave scattering on underside reflection at the core-mantle boundary. Phys. Earth Planet. Inter., 26, 266-267.

CHANG, A.C. & CLEARY, J.R., 1981: Scattered PKKP: Furthur evidence for scattering at a rough core-mantle boundary. Phys. Earth Planet. Inter., 24, 15-29.

CLEARY, J.R., 1981: Anomalous Rayleigh waves from nuclear explosions in East Kazakh, In: Identification of Seismic Sources - Earthquake or Underground Explosion, eds E.S. Husebye and S. Mykkeltveit, 191-199.

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Research interests and programs

The structure of the crust and upper mantle from Explosion Seismology.

Summary of research work since 1978

Investigation of the structure of the North Australian Craton using explosion seismology within the McArthur Basin.

Investigation of Crustal Structure within southeast Australia.

Interpretation of basement structures within the Eromanga Basin from shallow refraction data.

Application of synthetic seismograms and ray-tracing techniques to the interpretation of seismic data.

Publications since 1978

COLLINS, C.D.N., (in press) - Crustal structure of the southern McArthur Basin from deep seismic sounding. BMR J. Aust. Geol. & Geophys.

COLLINS, C.D.N., 1980: Deep crustal seismic investigations of the Eromanga Basin. In Moss F.J. (ed) Eromanga Basin Project Jan-June 1980. BMR Record, 1980/60 (unpublished).

COLLINS, C.D.N. & PINCHIN, J., 1980: McArthur Basin crustal seismic survey. Ninth BMR Symposium. BMR J. Aust. Geol. & Geophys., 5(3).

COLLINS, C.D.N., 1981: Crustal Seismic investigations in Northern Australia, 1979: Operational Report BMR Record 1981/2 (unpublished).

DRUMMOND, B.J., COLLINS, C.D.N. & GIBSON, G., 1979: The crustal structure of the Gulf of Papua and northwest Coral Sea. BMR J. Aust. Geol. & Geophys. 4(4), 341-351.

FINLAYSON, D.M. & COLLINS, C.D.N., 1980: A brief description of BMR portable seismic tape recording systems. Bull. Aust. Soc. Explor. Geophys., 11, 75-77.

FINLAYSON, D.M., PRODEHL, C. & COLLINS, C.D.N., 1979: Explosion seismic profiles and their implications for crustal evolution in southeastern Australia. BMR J. Aust. Geol. & Geophys. 4(3) 243-252.

FINLAYSON, D.M., COLLINS, C.D.N. & DENHAM, D., 1980: Crustal structure under the Lachlan Fold Belt southeastern Australia. Phys. Earth Planet. Inter., 21, 321-342.

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Research interests and programs

Geothermal Studies

Magnetotellurics

Summary of research work since 1978

GEOTHERMAL STUDIES

Aims and Significance:

To determine the heat flow regime in the various tectonic provinces of Australia relating any variations to crustal processes. The data will provide major constraints in models of regional tectonism and anomalies may indicate geothermal energy prospects. A thermal history calculated for individual locations will allow estimates to be made of factors affecting hydrocarbon maturation and mineral concentration.

Research Plan with Methods and Techniques:

Measurement of heat flow involves obtaining temperature data in deep drill-holes throughout Australia in cooperation with State surveys and private companies. In addition it will be necessary to initiate and conduct investigations in areas of special interest providing PVC casing to ensure thermal equilibrium. Temperature gradients will be measured with thermistor probes on 1000 m cable and thermal conductivity will be determined using a divided bar apparatus. Other thermal parameters will be determined after refining existing laboratory systems of measurement. Radiogenic heat production will be determined by contract using AMDEL analyses for U, K, Th.

MAGNETOTELLURIC STUDIES

Aims and Significance: Refine MT methods and equipment to determine electrical conductivity structures in sedimentary basins and other tectonic provinces. Expand inversion methods to include MT data in geological syntheses and evolutionary models. Further developments are required to enhance the resolving power and to demonstrate the advantages of MT where there are regions of highly conductive overburden.

Research Plan with Methods and Techniques: Initially it is proposed to occupy sites in regions of simple structure which are well determined from other methods. Data can then be obtained for correlation to prove the resolving power of existing MT systems. The method can then be extended to new survey areas in sedimentary basins and elsewhere it can be used as an aid to solving structural evolution.

New interpretation and recording systems must be developed suitable for Australia, and appropriate trials must be formulated for these techniques. The improved data will be used immediately to determine the conductivity structure of the crust and upper mantle and the geothermal gradient will be derived with other controls.

Publications since 1978

CULL, J.P., 1979: Geothermal Energy. Aust. Natural History, 19, 376-379.

CULL, J.P. & DENHAM, D., 1979: Regional variations in Australian heat flow. BMR J. Aust. Geol. & Geophys., 4(11), 1-13.

CULL, J.P., 1979: Heat flow and geothermal energy prospects in the Otway Basin, Southeast Australia. Search, 10(12), 429-433.

CULL, J.P., 1979: Climatic corrections to Australian heat flow data. BMR J. Aust. Geol. & Geophys., 4(4), 303-307.

CULL, J.P., 1980: A magnetotelluric approach to the structure of the Batten Trough, McArthur Basin. 9th BMR Symposium, Abstracts. BMR J. Aust. Geol. & Geophys., 5, 239.

CULL, J.P., 1980: Geothermal records of climatic change in NSW. Search, 11, 201-203.

CULL, J.P., 1981: Heat flow at standard depth. J. of Volcanol. & geotherm. Res., 9, 77-85.

VOZOFF, K. & CULL, J.P.: An electromagnetic method for rapid evaluation and some special problems. APEA Journal, Conference proceedings paper 6, (1981).

CULL, J.P., 1982: An appraisal of Australian heat flow data. BMR J. of Aust. Geol. & Geophys., 7 (1), 11-22.

CULL, J.P., SPENCE, A.G., MAJOR, J.A., KERR, D.W. & PLUMB, K.A., 1981: The 1978 McArthur Basin Magnetotelluric Survey. BMR Record 1981/1.

CULL, J.P. & SPENCE, A.G., 1981: The 1979 McArthur Basin Magnetotelluric Survey. BMR Record 1981/65.

CULL, J.P., 1982: Magnetotelluric profiles in the McArthur Basin of Northern Australia. BMR J. of Aust. Geol. & Geophys., 7 (4).

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Research interests and programs

Earthquake Seismology - particularly reservoir induced seismicity

Explosion Seismology

Summary of research work since 1978

The main objectives of GSQ research in the relevant field is to monitor seismicity levels in the vicinity of large reservoirs - before, during and after impounding, with a view to determining whether the reservoir has induced any earthquakes.

This office has been monitoring the Wivenhoe Dam, in conjunction with the University of Queensland, since 1977. This has been achieved with four microearthquake recorders which have been located in various subarrays around the dam.

A microearthquake network of three seismographs was installed in 1980 to monitor activity in the vicinity of the proposed Burdekin Falls Dam. Single instruments have also been installed at two other dams that are under construction. These are the Boondooma Dam and the Awoonga High Dam.

As none of the monitored dams has been completed, the only results obtained so far are for the natural or "Background" seismicity level - which does not seem to be unduly high in any of the areas being monitored.

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Research interests and programs

Earthquake seismology

Crustal stress

Structure of the lithosphere

Summary of research work since 1978

Using earthquake focal mechanisms, overcaring measurements and borehole deformation studies it has been shown that the Australian continential crust is in a state of compressive stress. Although there is some scatter in the results the maximum stress acts more E-W then N-S.

Publications since 1978

DENHAM, D., 1979: Earthquake Hazard in Australia, in R.L. Heathcote & B.G. Thom, Editors. NATURAL HAZARDS IN AUSTRALIA. Australian Academy of Science, Canberra.

DENHAM, D., ALEXANDER, L.G. & WOROTNICKI, G., 1979: Stresses in the Australian crust: evidence from earthquakes and in-situ stress measurements. BMR J. Aust. Geol. & Geophys., 4(3), 289-296.

DENHAM, D., ALEXANDER, L.G. & WOROTNICKI, G., 1979: Rock stress measurement in the Lachlan Fold Belt, NSW. CSIRO, Division of Applied Geomechanics Technical Report No. 84.

DENHAM, D. (Editor), 1979: Crust and upper mantle of southeast Australia, summaries of papers presented at Symposium held in Canberra, February, 1979. BMR, Record 1979/2.

DENHAM, D., ALEXANDER, L.G. & WOROTNICKI, G., 1980: The stress field near the site of the Meckering (1968) and Calingiri (1970) earthquakes, Tectonophysics, 67, 283-317.

DENHAM, D., 1980: The 1961 Robertson earthquake - more evidence for compressive stress in southeast Australia. BMR Journal of Australian Geology and Geophysics, 5, 153-156.

DENHAM, D., 1980: Earthquake prediction in China, some progress, some pitfalls. Search, 11(12), 422-3.

DENHAM, D., BOCK, G. & SMITH, R.S., 1982: The Appin (New South Wales) Earthquake of 15 November 1981. BMR J. of Aust. Geol. & Geophys., 7, 219-223.

EVERINGHAM, I.B., McEWIN, A.J. & DENHAM, D., 1982: Atlas of isoseismal maps of Australian earthquakes, Bull. Bur. Miner. Resour. Geol. Geophys. Aust., 214.

FINLAYSON, D.M., COLLINS, C.D.N. & DENHAM, D., 1980: Crustal structure under the Lachlan Fold Belt southeastern Australia. Phys. Earth Planet. Inter., 21, 321-342.

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Research interests and programs

Improvements in techniques to process seismic data

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Research interests and programs

Explosion seismology

Gravity in relation to isostasy, stress etc.

Magnetic anomalies and crustal structure -

Combination of data from various disciplines for study of the crust and/or lithosphere.

Summary of research work since 1978

1. Review of crustal structure in northeast Australia

An examination of data from gravity, deep seismic refraction and reflection surveys, long aeromagnetic profiles, and heat-flow determinations, in relation to the broader features of crustal structure in northern Queensland. Some apparent discrepancies between published interpretations were resolved.

2. Earth expansion hypothesis criticism

An answer to some criticisms of an earlier paper (1973), in which I showed from the gravity field over Australia that rapid expansion of the Earth could not be taking place. Also, demonstration of fallacies in several arguments claiming to prove Earth expansion.

3. Geophysical profile across Australia

An examination, particularly of long wave-length features, of the gravity and magnetic anomaly fields, and correlation with seismic and geothermal observations, with implications for crustal structure.

4. Palaeomagnetism as an indicator of stress arising from continental drift

Because the Earth is non-spherical, certain types of continental drift will involve changes in the curvature of moving plates. The palaeomagnetic polar wander path is a good indicator of the movements concerned. Stress and/or deformation must accompany such curvature changes; the expected effect should be enough to break the crust/lithosphere, but is hard to isolate from other stress effects.

5. MAGSAT (Jointly with P. Wellman, P. McGregor, A.S. Murray, and others).

A proposed study of the data from the MAGSAT magnetic satellite in relation to crustal anomalies in the Australian region. This will include combination with surface and airborne regional magnetic measurements, and correlation of the magnetic anomaly field with gravity, seismic and geothermal data.

6. Review of seismic explosion data (jointly with F.J. Moss)

A review of early seismic data on the deep crust acquired by BMR, with interpretation and writing up for publication.

Publications since 1978

DOOLEY, J.C., 1979: A geophysical profile across Australia at 29°S. BMR J. Aust. Geol. Geoph., 4, pp 353-359.

DOOLEY, J.C., 1980: A review of crustal structure in northeast Australia; in The geology and geophysics of north-eastern Australia (Stephenson, P.J., & Henderson, R.A., eds). Geological Society of Australia, Queensland Division, pp 27-45.

DOOLEY, J.C., 1982. Straight thinking on Meservey's circle. Search, 13, p 123.

DOOLEY, J.C., 1983. (a) Arguing in circles about Earth expansion. (b) A simple physical test of Earth expansion; in Proceedings of Expanding Earth Symposium, Sydney, 1981 (Carey, S.W., ed), pp 59-65 and 323-326.

DOOLEY, J.C. & McGREGOR, P.M., 1982: Australian geophysical data for use in correlation with MAGSAT data. Bull. Aust. Soc. Explor. Geophys, 13 (3), 63-67.

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Research interests and programs

Love waves at continental margins

Rayleigh and Love waves in offset coal seams

Summary of research work since 1978

Study has been done of the scattering and dispersion of Love waves at continental boundaries, including subduction zones. Study is continuing of the transmission and reflection of Rayleigh and Love waves in offset coal seams.

Publications since 1978

DRAKE, L.A., 1979: Elastic rebound of deeply eroded valleys; in Kabaila, A.P. & Pulmano, V.A. (Eds), Finite Element Methods in Engineering, pp. 701-712, Clarendon Press.

DRAKE, L.A., 1980: Love and Rayleigh waves in an irregular soil layer. Bull. seism. Soc. Am. 70, 571-582.

DRAKE, L.A. & BOLT, B.A., 1980: Love waves normally incident at a continental boundary. Bull. seism. Soc. Am. 70, 1103-1123.

DRAKE, L.A. & ASTEN, M.W., 1982: Wave propagation in irregular coal seams; in Hoadley, P.J. & Stevens, L.K. (Eds), Finite Element Methods in Engineering. pp 119-123, University of Melbourne (Paragon Printers).

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Research interests and programs

Explosion seismology, especially related to Archaean crustal evolution, and structures within and dynamics of the sub-crustal lithosphere.

Summary of research work since 1979

Since 1977, I have worked principally on the evolution of the crust in the Precambrian terrains of northwest Australia. The seismic refraction technique allied with gravity interpretation was used to develop crustal and upper mantle models for the region, and these models were then considered with the regional geology to place limits on the types of evolutionary processes which may have occurred.

The Archaean Pilbara and Yilgarn Cratons probably had separate evolutionary histories during the Archaean. The crust of the Pilbara Craton is chemically stratified, but is no more mafic than diorite at the base, and the crust/mantle boundary is a chemical discontinuity. Lateral velocity and density changes occur in the upper mantle throughout the region, and the upper mantle is also vertically stratified with the P-wave velocity in the uppermost layers anisotropic. The directions of anisotropy can be related to the directions of regional palaeostress implied by trends in the surface geology. The Archaean lithosphere was probably thinner than the present-day lithosphere, which is probably about 200 km thick.

Publications since 1978

DRUMMOND, B.J., 1979: A crustal profile across the Archaean Pilbara and northern Yilgarn Cratons, northwest Australia. BMR Jour. Aust. Geol. Geophys., 4, 171-180.

DRUMMOND, B.J., COLLINS, C.D.N. & GIBSON, G., 1979: The crustal structure of the Gulf of Papua and northwest Coral Sea. BMR Jour. Aust. Geol. Geophys., 4, 341-351.

DRUMMOND, B.J., 1981: Crustal structure of the Precambrian terrains of northwest Australia from seismic refraction data. BMR Jour. Aust. Geol. Geophys., 6, 123-135.

DRUMMOND, B.J. & SHELLEY, H.M., 1981: Isostasy and structure of the lower crust and upper mantle in the Precambrian terrains of northwest Australia, from regional gravity studies. BMR Jour. Aust. Geol. Geophys., 6, 137-143.

DRUMMOND, B.J., SMITH, R.E. & HORWITZ, R.C., 1981; Crustal structure in the Pilbara and northern Yilgarn Blocks from deep seismic sounding. Spec. Publ. Geol. Soc. Aust., 7, 33-41.

DRUMMOND, B.J., MUIRHEAD, K.J. & HALES, A.L., 1982: Evidence for a seismic discontinuity near 200 km depth under a continental margin. Geophys. Jour. R. astr. Soc., 70, 67-77.

DRUMMOND, B.J., 1982: Seismic constraints on the chemical composition of the Pilbara Craton, northwest Australia. Proc. Brazilian Geol. Congress, in press.

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Research interest and programs

Palaeomagnetism, Rock magnetism

Summary of research work since 1978

The application of modern methods in palaeomagnetism to the study of the evolution of the lithosphere. Particular research interests centre on elucidation of thermal events from studies of overprint remanent magnetism, investigation of magnetic signatures resulting from events related to passive rift-margin tectonics and the configuration of the geomagnetic field from reversal stratigraphic and apparent polar wander studies.

Publications since 1978

EMBLETON, B.J.J., & SCHMIDT, P.W., 1979: Recognition of common Precambrian polar wandering: a conflict with plate tectonics. Nature, 282, 705-707.

EMBLETON, B.J.J., VEEVERS, J.J., JOHNSON, B.D., & POWELL, C.McA., 1980: Palaeomagnetic comparison of a new fit of east and west Gondwanaland with the Smith and Hallam fit. Tectonophysics, 61, 381-390.

EMBLETON, B.J.J., & McDONNELL, K.L., 1980: Magnetostratigraphy in the Sydney Basin, south eastern Australia. J. Geomag. Geolect., 32 (SIII), 1-10.

SCHMIDT, P.W. & EMBLETON, B.J.J., 1981: A geotectonic paradox: has the Earth expanded? Jour. of Geophys., 49, 20-25.

McDOUGALL, IAN, EMBLETON, B.J.J. & STONE, D.B., 1981: Origin and evolution of Lord Howe Island, south west Pacific Ocean. Jour. Geol. Soc. Aust., 28, 155-176.

EMBLETON, B.J.J., 1981: A review of the paleomagnetism of Australian and Antarctica. In McElhinny, M.W. & Valencio, D.A. (Eds), Paleoreconstruction of the Continents, AGU Geodynamics Series Vol. 2, 77-92.

SCHMIDT, P.W. & EMBLETON, B.J.J., 1981: Magnetic overprinting in south eastern Australia and the thermal history of its rifted margin. J. Geophys. Res., 86, 3998-4008.

McELHINNY, M.W., EMBLETON, B.J.J., MaXINGHUA & ZHANG ZHENGKUN, 1981: Late Palaeozoic plate tectonics of China. Nature, 293, 212-216.

EMBLETON, B.J.J. & McELHINNY, M.W., 1982: Marine magnetic anomalies, palaeomagnetism and the drift history of Gondwanaland. Earth Planet. Sci. Letters, 58, 141-150.

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Research interests and programs

Explosion seismology, electrical conductivity, structure of the continental lithosphere and mantle, tectonics of the continental lithosphere.

Summary of Research work since 1978

General Direction

The application of explosion seismic refraction/reflection methods to investigate the lithospheric structure of continental Australia. This has been coupled with magnetotelluric methods of determining the conductivity structure of the continental crust and upper mantle.

Specific Projects

Structure of the North Australian Craton

Explosion seismic and magnetotelluric work in the McArthur Basin and seismic work between Tennant Creek and Mount Isa.

Teleseismic travel-time residual studies between Tennant Creek and Townsville

Conducted in cooperation with the Research School of Earth Sciences, Australian National University.

Investigations of Geophysical Differences between Precambrian and Phanerozoic Australia.

Examination of velocity-depth models of seismic velocity for both provinces and comparison with teleseismic travel-time anomalies.

Central Eromanga Basin Lithospheric Structure

The application of seismic refraction/reflection and magnetotelluric techniques to the determination of structural features of a major basin in Phanerozoic Australia.

Lithospheric structure of northern Australia

Seismic refraction investigation of lithospheric structure to depths of about 400 km using explosions on land and at sea, and also earthquake sources in the Banda Sea.

Publications since 1978

FINLAYSON, D.M., PRODEHL, C. & COLLINS, C.D.N., 1979: Explosion seismic profiles and their implications for crustal evolution in southeastern Australia. BMR J. Aust. Geol. & Geophys. 4, 243-252.

FINLAYSON, D.M., 1979: The Australian continental crust: explosion seismic studies in Archaean, Proterozoic and Palaeozoic provinces. IASPEI, Abstracts for the IUGG 17th General Assembly, Canberra, 84-85.

FINLAYSON, D.M., COLLINS, C.D.N. & DENHAM, D., 1980: Crustal structure under the Lachlan Fold Belt, southeastern Australia. Phys. Earth Planet. Inter., 21, 321-342.

FINLAYSON, D.M. & COLLINS, C.D.N., 1980: A brief description of BMR portable seismic tape recording systems. Bull. Aust. Soc. Explor. Geophys., 11, 75-77.

FINLAYSON, D.M., 1981: Reconnaissance of upper crustal seismic velocities in the Tennant Creek Block, Northern Territory. BMR J. Aust. Geol. & Geophys. 6, 245-252.

FINLAYSON, D.M., 1982: Geophysical differences in the lithosphere between Phanerozoic and Precambbian Australia. Tectonophysics, 84, 287-312.

FINLAYSON, D.M., 1982: Seismic crustal structure of the Proterozoic North Australian Craton between Tennant Creek and Mount Isa. J. Geophys. Res., 87, 10569-10578.

B.A. Gaull

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Research interests and programs

Earthquake Seismology

Geomagnetism

Summary of research work since 1978

In early 1979 completed MSc thesis on "Seismic risk at the 20 principal towns of Papua New Guinea"

1979-1981 - ANTARCTICA - Preparation for collating data after, together with 17 months in Antarctica itself left little time for research. Intend writing up on seismic disturbances associated with glaciation. Main thrust went into normal routine matters associated with running the seismic and geomagnetic observatories in Mawson, plus field work.

Publications since 1978

GREGSON P.J., PAULL E.P. & GAULL B.A., 1979: The effects in Western Australia of a major earthquake in Indonesia on 19 August 1977. BMR J. Aust. Geol. & Geophys., 4, 135-40.

Gary Gibson

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Research interests and programs

Main research interest is earthquake seismology

Explosion seismology sometimes used to develop lithospheric models.

Summary of research work since 1978

Seismicity and the Tectonic Structure of Victoria

Following installation of a network of microearthquake seismographs the number of small earthquakes located within the state of Victoria has greatly increased. The accuracy of earthquake location has also been improved, and it is now possible to determine focal mechanism solutions for some smaller earthquakes and composite mechanism solutions for sets of events within an area.

These seismological data together with geological and topographic information are being used to develop a tectonic model for the state. It is now apparent that there is a fairly uniform stress field over central Victoria with compression from south-east to north-west, producing a series of sub-parallel reverse faults striking south-west to north-east. A number of large wedge-shaped structures have developed where these faults have intersected. This movement probably commenced about mid-Miocene.

All well-located earthquakes are within the upper crust to a depth of no greater than twenty kilometres. As in many other intra-plate areas, it appears that the stress drop in local earthquakes is quite high.

The triaxial digital microearthquake seismographs recently installed are now beginning to provide a great deal more information about the mechanisms of small earthquakes.

Determination of Lithospheric Models Using Non-linear Least Squares

A program for the determination of seismic properties of the lithosphere using non-linear least squares methods is being developed. It has been used to derive an improved model of the Victorian lithosphere and will shortly be used to model the Bougainville Island region in New Guinea.

The program uses arrival time data from both explosions and earthquakes to simultaneously determine seismic P and S velocities, parameters defining the interfaces, and event location parameters. First arrivals, direct waves, head waves, simple reflections and direct waves that undergo one type conversion (e.g. from P to S) can be used.

Models with horizontal interfaces and constant velocities in each layer are currently being used, the model of Victoria consisting of seven layers. The program has the facility to use interfaces that vary in depth over the region as a simple function of position, or to include layers with velocity variations, but these are not used at present.

Development of a Computer Based Seismological Interpretation System

The rate at which seismological data are now being accumulated is such that computer handling is almost essential for routine procedures. A system is being developed at PIT which includes integrated and interactive computer programs for the following:

1. Replay, analysis and storage of digital seismograms.
2. Determination of earthquake locations and mechanisms.
3. Production of an earthquake catalogue and use of this to produce selective listings and plots of earthquakes, and to determine earthquake magnitude recurrence statistics for an area.
4. Use of the earthquake catalogue and a spectral attenuation function to produce ground motion recurrence statistics.

5. Use of these ground motion recurrence statistics together with a triaxial digital seismogram of a small local earthquake to produce a synthetic accelerogram for a particular site.
6. Use of this synthetic accelerogram together with dynamic properties of a structure to determine the response of the structure to an earthquake.

Digital Seismograph Development

A microprocessor-controlled digital seismograph system has been developed and used in a wide range of applications. The recorder usually operates as a triggered recorder, storing data in a memory queue and examining it for earthquake arrivals. When an earthquake is detected, it is recorded on tape from the start of the queue. Use of this queue means that the first motion of the earthquake will normally be recorded.

The recorder normally records 100 or 200 samples per second on each of three channels, and it normally records a short-wave radio time signal to provide backup and correction for its precision clock.

The recorder has been used with triaxial wide dynamic range accelerometers and seismometers. Apart from recording earthquakes, it has been used to record blasts and the natural vibration of structures.

In addition to the recorders in Victoria, a network of three has been installed in Papua New Guinea and is being used to gather data on deep earthquakes in a Benioff Zone.

Publications since 1978

DRUMMOND, B.J., COLLINS, C.D.N. & GIBSON, G., 1979: The crustal structure of the Gulf of Papua and Northwest Coral Sea. BMR J. Aust. Geol. & Geophys., 4, 341-351.

GIBSON, G., WESSON, V. & CUTHBERTSON, R., 1981: Seismicity of Victoria to 1980. J. Geol. Soc. Aust., 28, 341-356.

GIBSON, G., 1982: Earthquakes, in Duncan, J.S. (ed), Atlas of Victoria, Victorian Government Publication, Melbourne.

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Research interests and programs

(i) Magnetostratigraphy of the western part of the Middle Proterozoic McArthur Basin, N.T., Australia

(ii) Palaeomagnetic studies on dated Proterozoic igneous rocks of Australia

(iii) Palaeomagnetic investigation of the tectonic evolution of the Vogelkop regional Irian Jaya Province, Eastern Indonesia.

(iv) Palaeomagnetism of Precambrian dyke swarms in Antarctica

Summary of research work since 1978

(i) Magnetostratigraphy of the western part of the Middle Proterozoic McArthur Basin, N.T., Australia.

This project aims at establishing the feasibility of using magnetostratigraphy as a correlation tool in the Middle Proterozoic rock sequences from northern Australia and, as a by-product, seeks to refine the middle Proterozoic a.p.w path for Australia. The basal 1650 My Kombolgie Sandstone has been chosen as the start formation, and 2 duplicate sections, 200 km apart, and up to 1 km thick, have been collected at regular 1 m intervals. Preliminary work has defined a tentative polarity pattern for one section, poles which agree between the 2 sections, and a polar shift which can be correlated with a shift from similar aged rocks in the eastern McArthur Basin, 400 km away, allowing a refined correlation of rocks between the 2 areas. To handle the data generated by the project (and others) effectively, a 10 Mbyte database has been set up. This processes and plots incoming raw, cryogenic and digico, magnetometer data, recorded on cassettes, and through its link to a graphics VDU, enables interrogation and interactive analysis of that data.

(ii) Palaeomagnetic studies on dated Proterozoic igneous rocks of Australia.

By establishing well-defined palaeomagnetic poles for dated Proterozoic igneous rocks, this project is designed to improve the first order a.p.w. path for Australia for the Proterozoic and provide time calibration points. So far samples have been collected from the Stuart Dykes (Central Australia, 897 My), Morawa Lavas (W.A., 1361 My), and Edith River Volcanics (N.T., 1730 My). Preliminary results are:

(a) The Stuart Dykes pole lies 35° away from the published YB pole (735-685 My) on an older part of the curve

(b) Poles from the Morawa Lavas and the overlying and underlying sandstones define a 35° path segment which is not only 40° removed from an earlier published pole for the Lavas, but the sense of polar motion through the Lavas pole is opposite to that published.

(c) The Edith River Volcanics pole is 25° from the result published over 20 years ago based on uncleaned remanence.

Results from this project and the McArthur Basin magnetostratigraphy require substantial modifications to be made to the Proterozoic a.p.w. path for Australia. The main features of the updated path are

(a) Definition of a new loop in the 1760-1660 My time interval.

(b) The loop connecting poles younger than 1525 My is different and opposite in sense to that published.

(iii) Palaeomagnetic investigation of the tectonic evolution of the Vogelkop region, Irian Jaya Province, Eastern Indonesia.

Palaeomagnetic research in the Vogelkop region aims to improve our understanding of how this region evolved into its present orientation with respect to the rest of Irian Jaya - substantial rotation about a local axis, translation, no change. Any movement is expected to be of Tetiary age. To this

end, 9 formations (353 samples), ranging in age from Permo-Carboniferous to Middle Miocene have been collected in order to define a first-order a.p.w. path for the Vogelkop. Comparison of this path with that for Australia for the same time span should provide an insight into the problem. It is a joint project with the Geological Research and Development Centre, Bandung, Indonesia and also involves upgrading of their palaeomagnetic laboratory.

(iv) Palaeomagnetism of Precambrian dyke swarms from Antarctica

Palaeomagnetic studies of the Precambrian dykes in Enderby Land, Antarctica are designed to yield pole positions which, when dated, will help assess the status of Antarctica in Gondwanaland during the Precambrian. 60 or so dykes have been sampled so far; initial results fall into 3 groups, suggesting that the dykes belong to at least 3 distinct phases of intrusion.

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Research interests and programs

Plate Tectonics

Earthquake Prediction

Earthquake Dynamics

Summary of research work since 1978

Design, development and deployment of a series of 25 proton precession remote monitoring stations in the area from East New Guinea through the Solomon Islands to Vanuatu. The stations are microprocessor controlled and synchronously sample the field to 0.25γ every five minutes. Every three hours data are returned to USA via satellite and selected data are printed on site.

Eleven stations came on line in June 1980 and the remainder in June 1981. Analysis of instantaneous differences has shown very high stability of data.

The objective of the programme is to determine whether or not a piezomagnetic effect occurs for large ($M>7$) shallow earthquakes. Data will be collected for at least another 2 years, by which time at least one event is expected in the array.

Ronald Green

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Research interests and programs

Operation of seismograph

Measurement of tidal tilt

Measurement of tidal strain

Summary research work since 1978

Daily return of seismic records to BMR.

Accumulation of tidal tilt and strain data.

Publications since 1978

GREEN, R., 1979: Predictive profiling: the 5-point method of interpretation (magnetic gradients). Bull. Aust. Assn. Expl. Geophys. 10, 96-98

GREEN, R., 1979: A note on the Hilbert Transform. Bull. Aust. Assn. Expl. Geophys. 10, 129-130

GREEN, R., 1979: Notes on the magnetic units used in Geophysics. Bull. Aust. Assn. Expl. Geophys. 10, 125-128

GREEN, R., 1979: The harmonic method of inverting a magnetic profile over a contact. Geoexploration, 17, 261-268,

GREEN, R., 1980: The field processing of magnetic data. Geophys. Prosp., 28, 384-391.

WHITTON, C.A., GREEN, R., & MEADE, B.K., (Eds.), 1979: Recent Crustal Movements, 1977, Tectonophysics, 52, 1-664.

GREEN, R., ADKINS, J.S. HARRINGTON, H.J. & UNTUNG, M.,1980: Bouguer Gravity Anomaly Map of Indonesia (1:500 000). University of New England Publishing Unit, Armidale NSW 2351.

GREEN, R., ADKINS, J.S. HARRINGTON, H.J. & UNTUNG, M. 1981: Bouguer Gravity Map of Indonesia. Tectonophysics, 71.

S.A. Greenhalgh

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Research interests and programs

Explosion seismology

Seismicity studies

Synthetic seismograms.

Summary of research work since 1978

The experimental/observational seismology projects were undertaken in North America and as such are probably not relevant to this report. Details can be provided upon request (see titles in publication list).

Publications since 1978

MERRICK, N., COINS, J. & GREENHALGH, S.A., 1978: A blind zone solution to the problem of hidden layers within a sequence of horizontal or dipping refractors. Geophys. Prosp., 26, 703-721.

MOSHER, C.C., GREENHALGH, S.A. & MOONEY, H.M. 1979: Geological interpretation of teleseismic residuals on the Central Minnesota Seismic Array. Paper presented at 74th Annual Meeting of Seismological Society of America, May, Golden Co. (Abstract).

GREENHALGH, S.A., MOONEY, H.M. & MOSHER, C.C., 1980: The Minnesota seismic network. Bull. Seism. Soc. Am., 70, 1347-1368.

GREENHALGH, S.A., 1980: Effects of delay shooting on the nature of P-wave seismograms. Bull. Seism. Soc. Am., 70, 2037-2050.

GREENHALGH, S.A., KING, D.W. & EMERSON, D.W., 1980: On the fitting of velocity functions to seismic refraction data. Bull. Aust. Soc. Expl. Geophys. 11, 78-91.

GREENHALGH, S.A. & KING, D.W., 1980: Determination of velocity-depth distributions by inversion refraction time-distance data. Bull. Aust. Soc. Expl. Geophys., 11, 92-98.

GREENHALGH, S.A. 1981: Seismic investigations of crustal structure in East-Central Minnesota. Phys. Earth & Plan. Int., 25, 372-389.

GREENHALGH, S.A., MOSHER, C.C. & MOONEY, H.M., 1981: Magnitude calibration of the Central Minnesota Seismic Array. Bull. Seism. Soc. Am., 71, 1089-1104.

GREENHALGH, S.A. & KING, D.W., 1981: Curved raypath interpretation of seismic refraction data. Geophys. Prosp., 29, 853-882.

P.J. Gregson

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Research interests and programs

Earthquake seismology

Geomagnetism

Summary of research work since 1978

Earthquake Seismology - Research on earthquake distribution, wave attenuation, foreshocks, aftershocks, magnitudes, mechanisms, prediction and other features in order to determine (a) the tectonic implications of seismicity and (b) earthquake risk.

Approach - operation of network of seismographs and accelerographs in WA and to analyse data. To analyse strong motion recordings.

Geomagnetism - Study of secular variation.

Publications since 1978

GREGSON, P.J., PAULL, E.P. & GAULL, B.A., 1979: The effects in Western Australia of a major earthquake in Indonesia on 19 August 1979. BMR J Aust. Geol. Geophys., 4, 135-140.

GREGSON, P.J. & PAULL, E.P., 1979: Preliminary report on the Cadoux Earthquake, 2 June 1979. BMR Report 215.

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Research interests and programs

The use of synthetic seismograms in delineating the upper mantle and transition zone.

Summary of research work since 1978

In anticipation of high-quality data which is expected to be available from a major field experiment using the new digital instruments in 1982, three synthetic seismogram programmes using generalised ray theory, the WKBJ approximation and the reflectivity method have been implemented on the Univac Computer in the University's Computer Service Centre. The programmes are presently being used on simple Earth models to obtain an understanding of their limitations and to determine what resolution in seismic velocity structure is available as a function of frequency.

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Research interests and programs

Geomagnetism

Summary of research work since 1978

1978-1980

Involved in a programme to determine the contribution of the Earth's atmosphere to fluctuations in the Earth's rate of rotation. This entailed the integration over the globe of the monthly mean zonal wind speed component to find the mean total angular momentum of the atmosphere each month. Data for some 22 years were analysed this way. Since the angular momentum of the Earth-atmosphere system is constant, variations in that of the atmosphere imply variations in the Earth's rotation rate. The contribution to variable rotation rate due to the atmosphere may be eliminated to yield that due to other causes within the Earth.

1982 -

Involved in the operation of geomagnetic observatories, processing and distribution of data.

Interested in the morphology of the geomagnetic field.

Publications since 1978

LAMBECK, K. & HOPGOOD, P., 1981: The Earth's rotation and atmospheric circulation, from 1963-1973, Geophys. J.R. astr. Soc., 64, 67-89.

LAMBECK, K. & HOPGOOD, P., 1982: The Earth's rotation and atmospheric circulation: 1958-1980, Geophys. J.R. astr. Soc., 71, 581-587.

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Research interests and programs

Palaeomagnetism

Summary of research work since 1978

Cainozoic Apparent Polar Wander. The existing Australian Cainozoic polar-wander path is being refined in order to develop palaeomagnetism as a dating tool and to improve our knowledge of the Cainozoic drift history of the continent. Unlike the original pole path which was established by measurements on igneous rocks, the revised pole path is being determined principally from sedimentary rocks and laterites. Four dated and several undated pole positions have been obtained so far.

Palaeomagnetic Studies of the Eastern McArthur Basin. The aims of this project are to establish a Carpentarian pole path segment for the Northern Australian craton and to investigate the application of magnetostratigraphy to Carpentarian rocks. A preliminary pole path and magnetostratigraphic column have been obtained for 1000 m thickness of McArthur Basin sediments spanning the upper Tawallah and lower to middle McArthur Groups.

Proterozoic Palaeomagnetism of Antarctica. Proterozoic mafic dykes of Enderby Land and Vestfold Hills (Princess Elizabeth Land) are being investigated to obtain pole palaeomagnetic positions as constraints on the reconstruction of Eastern Antarctica relative to the other Gondwana continents. Measurements have been completed on 53 dykes of Enderby Land yielding one well defined and two less well defined groups of directions. Measurements are in progress on a

further 23 dykes to consolidate the less-well defined groupings. Pilot measurements have been completed on 45 mafic dykes of Vestfold Hills, yielding directional groupings that are similar to those of the Enderby Land dykes.

Publications since 1978.

TYNE, E.D., IDNURM, M. & MALONE, E.J., 1980: Physical properties of the Woodlawn ore body and surrounding rocks. In Geophysical Case Study of the Woodlawn Ore Body, ed. Whiteley, R.J. Pergamon (Oxford), 618 pp.

COOK, P.J. & IDNURM, M., 1981: Ice and sea: ice ages and sea level changes around Australia. Hemisphere, 26, 116-120.

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Research interests and programs

Earthquake and explosion seismology, with particular reference to single- and multi-channel data processing and inversion.

Summary of research work since 1978

Current research includes the development of novel processing strategies to enhance the resolution of composited arrivals as recorded by large seismic arrays. Decomposition of long-period wave trains into well separated discrete arrivals enables construction of a well constrained upper mantle velocity model. This model may be used as a starting point for model refinement by matching with synthesized seismograms. The technique of crustal transfer ratios has been used to delineate the nature of the crust beneath the ASRO station of Charters Towers. This study showed that the simplicity of implementation and interpretation of the method makes it potentially useful for gross crustal structure determination using long-period P recorded by portable seismometer packages sited in remote areas.

Publications since 1978

CLEARY, J.R., INGATE, S.F., KING, D. & WANG, C., 1982: Upper mantle modelling using long-period SH-wave trains. Phys. Earth. Planet. Inter., 30, 36-48.

Kurt Lambeck

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Research interests, and programs

Planetary gravity fields

Strength of the earth's lithosphere

Tectonophysics

Rotation of the earth

Viscosity of the earth's mantle

Summary of research work since 1978

See publications list below.

Publications since 1978

CAZENAVE, A., LAMBECK, K. & DOMINH, K., Studies of the GEOS 3 altimeter derived geoid undulations over seamounts in the Indian Ocean. In The Use of Artificial Satellites for Geodesy and Geodynamics, Ed. G. Veis. National Technical University Press, Greece, 1979.

LAMBECK, K., 1979: Methods and geophysical applications of satellite geodesy. Rept. Prog. Phys., 42, 547-628.

LAMBECK, K., 1979: The history of the Earth's rotation. The Earth: Its Origin, Structure and Evolution, Ed. M.W. McElhinny, Academic Press, 59-81.

LAMBECK, K., 1979: On the orbital evolution of the Martian satellites. J. Geophys. Res., 84, 5651-5658.

LAMBECK, K., 1979: Comments on the gravity and topography of Mars. J.Geophys. Res., 84, 6241-6247.

LAMBECK, K., 1979: Estimates of the finite strength of the lithosphere from isostatic considerations. Magnitude of Deviatoric Stresses in the Earth's Crust and Upper Mantle, Ed. Evernden, J., U.S. Geol. Survey, Menlo Park.

MERRIAM, J.B. & LAMBECK, K., Comments on the Chandler wobble Q. Geophys. J.R. astr. Soc., 59, 281-286, 1979.

LAMBECK, K. & NAKIBOGLU, S.M., 1979: Seamount loading of the oceanic lithosphere. Magnitude of Deviatoric Stresses in the Earth's Crust and Upper Mantle, Ed. Evernden, J., U.S. Geol. Survey, Menlo Park.

CAZENAVE, A., LAGO, B., DOMINH, K. & LAMBECK, K., On the response of the ocean lithosphere to seamount loads from GEOS 3 satellite radar altimeter observations. Geophys. J.R. astr. Soc., 63, 233-252, 1980.

LAMBECK, K., 1980: The Earth's variable rotation: Geophysical causes and consequences. Cambridge University Press, 450pp.

LAMBECK, K., 1980: Estimates of stress-differences in the crust from isostatic considerations. J. Geophys. Res., 85, 6397-6402.

LAMBECK, K., 1980: Changes in length-of-day and atmospheric circulation. Nature, 286, 104-105.

LAMBECK, K., 1980: The Earth's variable rotation. New Scientist, 426-429.

LAMBECK, K. & NAKIBOGLU, S.M., 1980: Seamount loading and stresses in the ocean lithosphere. J. Geophys. Res., 85, 6403-6418.

LAMBECK, K. & PULLAN, S., 1980: Inferences on the lunar temperature from gravity stress state and flow laws. Phys. Earth Planet. Inter., 22, 29-35.

LAMBECK, K. & PULLAN, S., The lunar fossil bulge hypothesis revisited. Phys. Earth Planet. Int., 22, 29-35, 1980.

PHILLIPS, R.J. & LAMBECK, K., Gravity fields of the terrestrial planets: Long-wavelength anomalies and tectonics. Revs. Geophys. and Planet. Phys., 18, 27-76, 1980.

PULLAN, S. & LAMBECK, K., On constraining lunar mantle temperatures from gravity data. Proc. Lunar Planet. Sci. Conf. 11th, 2031-2041, 1980.

LAMBECK, K., 1981: Some geodetic aspects of the plate tectonics hypothesis. In: Reference Coordinate Systems for Earth Dynamics, eds. E.M. Gaposchkin and B. Kolaczek, Reidel, 87-101.

LAMBECK, K., 1981: Flexure of the ocean lithosphere from island uplift, bathymetry and geoid height observations: The Society Islands. Geophys. J. Roy. astr. Soc., 67, 91-114.

LAMBECK, K., 1981: Lithospheric response to volcanic loading in the Southern Cook Islands. Earth Planet. Sci. Lett., 55, 482-496.

LAMBECK, K., 1981: Gravitational mechanics of the Earth. In: Cambridge Encyclopedia of Earth Sciences, 93-108.

LAMBECK, K., 1981: Comment on "Development and analysis of a twelfth degree and order gravity field of Mars" by E.J. Christensen and G. Balmino. J. Geophys. Res., 86, 6382.

LAMBECK, K. & HOPGOOD, P., 1981: The Earth's rotation and atmospheric circulation, from 1963-1973. Geophys. J. Roy. astron. Soc., 64, 67-89.

LAMBECK, K. & NAKIBOGLU, S.M., 1981: Seamount loading and stress in the ocean lithosphere, 2. Viscoelastic and elastic-viscoelastic models. J. Geophys. Res., 86, 6961-6984.

NAKIBOGLU, S.M. & LAMBECK, K., Deglaciation related features of the Earth's gravity field. Tectonophysics, 72, 289--303, 1981.

SZETO, A. & LAMBECK, K., On eccentricity functions of eccentric orbits. Celestial Mechanics, 27, 325-337, 1982.

PULLAN, S. & LAMBECK, K., Mascons and loading of the lunar lithosphere. Proc. Luna Sci. Conf. 12th, 853-865, 1982.

LAMBECK, K. & HOPGOOD, P., The Earth's rotations and atmospheric circulation: 1958-1980. Geophys. J.R. astr. Soc., 71, December 1982.

NAKIBOGLU, S.M., and LAMBECK, K., A study of the Earth's response to loading with application to Lake Bonneville. Geophys. J.R. astr. Soc., 70, 577-620, 1982.

LAMBECK, K., & COLEMAN, R. Verification of bathymetric charts from satellite altimetry data in the region of the Cook Islands. New Zealand J. Science, 25, 183-194, 1982.

LAMBECK, K. & COLEMAN, R., A search for seamounts in the Southern Cook and Austral region. Geophys. Res. Lett., 9, 389-392, 1982.

LAMBECK, K., The core and the Earth's rotation. Proc. Roy. Soc. Lond., A306, 269, 1982.

LAMBECK, K., Bumps on the core mantle boundary. Proc. Roy. Soc. Lond., A306, 287, 1982.

LAMBECK, K., Where has that Moon been? Nature, 298, 704-705, 1982.

F.E.M. Lilley

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Research interests and programs

Electrical conductivity determinations of the earth's interior and significance of this parameter in terms of composition, temperature and fabric. (Note relevance of this topic to IAGA Working Group I-3 which covers 'Electromagnetic induction and electrical conductivity of the Earth and Moon', and also to the 'ELAS' project on the Electrical Conductivity of the Asthenosphere).

Summary of research work since 1978

1. Interpretation of Australian magnetometer array data to obtain profils of electrical conductivity beneath central Australia and beneath south-east Australia. Demonstration of fundamental difference between the two areas, with higher conductivity beneath south-east Australia in depth range 200-300 km interpreted in terms of small degree of partial melt.
2. Magnetometer array studies in India.

Publications since 1978

LILLEY, F.E.M., 1979: Magnetic daily variations compared between the east and west coasts of Canada. Can. J. Earth Sci., 16, 585-592.

WOODS, D.V. & LILLEY, F.E.M., 1979: Geomagnetic induction in central Australia. J. Geomag. Geoelectr., 31, 449-458.

LILLEY, F.E.M., 1980: The electrical conductivity structure of geodynamic processes. Tectonophysics, 63, 387-395.

WOODS, D.V. & LILLEY, F.E.M., 1980: Anomalous geomagnetic variations and the concentration of telluric currents in south-west Queensland, Australia. Geophys. J. R. astr. Soc., 62, 675-689.

LILLEY, F.E.M., WOODS, D.V. & SLOANE, M.N., 1981: Electrical conductivity from Australian magnetometer arrays using spatial gradient data. Phys. Earth Planet. Inter., 25, 202-209.

LILLEY, F.E.M., SINGH, B.P., ARORA, B.R., SRIVASTAVA, B.J., PRASAD, S.N., & SLOANE, M.N., 1981: A magnetometer array study in north-west India. Phys. Earth Planet. Inter., 25, 232-240.

LILLEY, F.E.M., WOODS, D.V. & SLOANE, M.N., 1981: Electrical conductivity profiles and implications for the absence or presence of partial melting beneath central and southeast Australia. Phys. Earth Planet. Inter., 25, 419-428.

LILLEY, F.E.M. & SLOANE, M.N., 1981: Ideal phase in estimating the spatial gradient of magnetic daily variations recorded by magnetometer arrays. J. Geomag. Geoelectr., 33, 517-525.

R.D. List

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Research interests and programs

Earthquake seismology

Summary of research since 1978

The computer modelling of earthquakes needs exact solutions of mathematical models for checking. The work so far has extended the known exact solutions of Haskell's fault model.

Publications since 1978

LIST, R.D., 1982: The solution of the Dynamic Field of the Haskell Fault Model Reconsidered. Bull. Seism. Soc. Am., 72, 1069-1083.

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Research interests and programs

Geomagnetic polarity time scale and history of the geomagnetic field.

Summary of research since 1978

a. Elucidation of the geomagnetic polarity time scale back to 13 Ma ago by direct measurement of lava sequences in Iceland.

b. Analysis of behaviour of the geomagnetic field from palaeomagnetic measurements on Icelandic lavas.

c. Palaeomagnetic studies on volcanic rocks of Lord Howe Island have assisted in understanding the geological evolution of this volcano.

Publications since 1978

McDOUGALL, I., 1979: The present status of the geomagnetic polarity time scale; in McElhinny, M.W. (ed.): The Earth, Its Origin, Structure and Evolution, 543-565, Academic Press, London.

HARRISON, C.G.A., McDOUGALL, I. & WATKINS, N.D., 1979: A geomagnetic reversal time scale back to 13.0 million years before present. Earth planet. sci. Lett., 42, 143-152.

SAEMUNDSSON, K., KRISTJANSSON, L., McDOUGALL, I. & WATKINS, N.D., 1980: K-Ar dating, geological and paleomagnetic study of a 5-km lava succession in Northern Iceland. J. geophys. Res. 85, 3628-3647.

McDOUGALL, I., EMBLETON, B.J.J. & STONE, D.B., 1981: Origin and evolution of Lord Howe Island, Southwest Pacific Ocean. J. geol. Soc. Austra., 28, 155-176.

KRISTJANNSON, L. & McDOUGALL, I., 1982: Some aspects of the Late Tertiary geomagnetic field in Iceland. J.R. astron. Soc. geophys., 68, 273-294.

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Research interests, and programs

Geomagnetism

Secular variation and morphology of the Magnetic Field in Australia and Antarctica

Earthquake risk

Summary of research work since 1978

Geomagnetism: - Secular variation and morphology of the magnetic field in the Australian region and Antarctica.

Objective: To undertake surveys, produce charts, derive models and study the secular change of the geomagnetic field in the Australian region and Antarctica.

Approach: Short term recording (3 days) at sixty five first order stations distributed over Australia and offshore islands and third order surveys in Antarctica, to supplement data from the permanent observatories in the region.

The 1980.0 Epoch isomagnetic charts of the Australian region were derived by fitting a fourth degree polynomial to the reduced observations to provide smoothed contours of the magnetic elements and secular variation representative of the broad scale regional field.

Publications since 1978

McGREGOR, P.M., WINCH, D.E. & McEWIN, A.J., 1982: A preliminary assement of International Geomagnetic Reference Field Models for Australia. J. Geomag. Geoelectr., 34.

EVERINGHAM, I.B., McEWIN, A.J. & DENHAM, D., 1982: Atlas of isoseismal maps of Australian earthquakes. Bull. Bur. Miner. Resour. Geol. Geophys. Aust., 214.

McEWIN, A.J., McGREGOR, P.M. & SMALL, G.R., 1982: Total Magnetic Intensity Chart, Epoch 1980.0.

McEWIN, A.J., McGREGOR, P.M. & SMALL, G.R., 1982: Magnetic Declination Chart, Epoch 1980.0.

SMITH, R.S., & McEWIN, A.J., 1980: Earthquake accelerograms and attenuation of seismic waves at Oolong, NSW. BMR J. Aust. Geol. Geophys.,5.

DENHAM, D. & McEWIN, A.J., 1980: Earthquakes. Earth Science Atlas. Bur. Miner. Resour. Geol. Geophys. Aust.

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Research interests and programs

Palaeomagnetism.

Summary of Research work since 1978.

A. Fisher Statistics

Research into applications of the Fisher distribution has been performed in order to improve the general analysis of palaeomagnetic data. This research is continuing and alternative distributions on a sphere will be considered.

B. Dating of multicomponent magnetizations

Research into the combination of $^{40}Ar/^{39}Ar$ data with multicomponent palaeomagnetic data in order to provide dates for individual magnetic components has been initiated. The Rameka Diorite (South Island, New Zealand) has a relatively simple geometry and thermal history and is therefore attractive as a region for a pilot study. Samples have therefore been collected from this region and work is in progress.

C. Palaeomagnetic constraints on dynamo theory

The distributions of apparent dipole moments and polarity reversal sequences are at present being studied. It is hoped that these studies will lead to a better understanding of the earth's magnetic field and its generation.

Publications since 1978

McFADDEN, P.L., BROCK, A. & PARTRIDGE, T.C., 1979: Palaeomagnetism and the age of the Makapansgat Hominid Site. Earth Planet. Sci. Lett. 44, 373-382.

McFADDEN, P.L., 1980: Determination of the angle in a Fisher distribution which will be exceeded with a given probability. Geophys. J.R. astro. Soc., 60, 391-396.

McFADDEN, P.L., 1980: The best estimate of Fisher's precision parameter k. Geophys. J.R. astro. Soc., 60, 397-407.

McFADDEN, P.L., 1980: Testing a palaeomagnetic study for the averaging of secular variation. Geophys. J.R. astro. soc., 61, 183-192.

McFADDEN, P.L., 1980: Simple graphical methods for estimating the confidence region about the orientation of the intersection of two planes: Discussion. Can. J. Earth Sci., 17, 1111-1113.

McFADDEN, P.L. & JONES, D.L., 1981: The fold test in palaeomagnetism. Geophys. J.R. astro. Soc., 67, 53-58.

McFADDEN, P.L, 1981: A theoretical investigation of the effect of individual grain anisotropy in alternating field demagnetization. Geophys. J.R. astro. Soc., 67, 35-51.

McFADDEN, P.L. & LOWES, F.J., 1981: The discrimination of mean directions drawn from Fisher distributions, Geophys. J.R. astro. Soc., 67, 19-33.

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Research interests and programs

Explosion Seismology - deep reflection studies

Summary of research work since 1978

The objective of the deep reflection studies is to obtain high-resolution information on the structure and composition of the crust and upper mantle in Australia. Deep reflection data to 20 s are being recorded on all traverses during the normal surveys in the central Eromanga Basin, Qld. The data recorded to date amount to 6-fold coverage over about 1400 km of traverses. The preliminary results show good quality reflections from the deep crust as well as from the sedimentary layers. The character of the deep reflections suggests that the lower crust (about 20-40 km) is strongly layered with short and thin laminae of aternating high and low velocity.

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Research Interests and program

Earthquake and explosion seismology

Publications since 1978

RAM DATT & MUIRHEAD, K.J., 1978: P-wave low velocity layer in the upper mantle. VI Symposium on Earthquake Engineering, University of Roorkee, Vol 1.

HALES, A.L., & MUIRHEAD, K.J., 1980: The ratio of travel times for S and P at distances less than 10°. Bull. Seismol. Soc., Amer., 70, 823-829.

HALES, A.L., MUIRHEAD, K.J. & RYNN, J.M.W., 1980: A compressional velocity for the upper mantle. Tectonophysics, 63, 309-348.

MUIRHEAD, K.J. & HALES, A.L., 1980: Evidence for P wave velocity discontinuities at depths greater than 650 km in the mantle. Phys. Earth Planet. Inter., 23, 304-313.

HALES, A.L., MUIRHEAD, K.J. & RYNN, J.M.W., 1980: Crust and upper mantle shear velocities from controlled sources. Geophys. J. R. astr. Soc., 63, 659-670.

HALES, A.L., MUIRHEAD, K.J. & MAKILOPEZ, L., 1981: The times of origin and depths of focus of intermediate and deep focus earthquakes - model calculations. Bull. Seismol. Soc. Amer., 71, 1539-1552.

MUIRHEAD, K.J., 1981: Seismicity induced by the filling of the Talbingo Reservoir. J. Geol. Soc. Aust., 28, 291-298.

DRUMMOND, B.J., MUIRHEAD, K.J. & HALES, A.L., 1982: Evidence for a seismic discontinuity near 200 km depth under a continental margin. Geophys. J. R. astr. Soc., 70, 67-77.

W.D. Parkinson,

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Research interests and programs

Geomagnetic induction studies

Summary of research work since 1978

The object of the project is to determine the underground electrical conductivity in northern Tasmania. The technique is to record the three components of the time-varying geomagnetic field and attempt to correlate the vertical component with horizontal components. A horizontally stratified conductivity structure results in only small vertical variations. A conductivity anomaly has been discovered near Scottsdale. Future work seeks to delineate the

ly more exactly and to determine the depth distribution of conductivity by anomading the technique to magneto-telluric recording.

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Publications since 1978

PARKINSON, W.D., 1980: Induction by Sq. Jour. Geomag. Geoelect. 32 Supp I, 79-88.

PARKINSON, W.D. & JONES, F.W., 1979: The Geomagnetic Coast Effect. Rev. Geophys. Space. Phys. 17, p. 1999.

PARKINSON, W.D. & HOBBS, B.A., 1979: Conditions for the Geomagnetic Induction Relationship. Phys. Earth Plant. Int. 19, 5.

PARKINSON, W.D, (joint Editor) 1981: Electrical Conductivity and the Characteristics of the Asthenosphere. Phys. Earth Planet. Int., 25 (3) (special issue).

E.P. Paull

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Research interests and programs

Earthquake Seismology,

Geomagnetism

Summary of research work since 1978

Objectives - To determine (a) the tectonic implications of local seismicity and (b) earthquake risk.

Approach - Operation of a network of seismographs in Western Australia and undertake research on earthquake distribution, wave attenuation, foreshocks, aftershocks, local magnitudes, mechanisms and prediction.

Publications since 1978

GREGSON, P.J., PAULL E.P. & GAULL B.A., 1979: The Effects in Western Australian of a Major Earthquake in Indonesia on 19 August 1979. BMR J. Aust. Geol. Geophys., 4, 135-140.

GREGSON, P.J. & PAULL E.P., 1979: Preliminary Report on the Cadoux Earthquake, 2 June 1979. BMR Report 215.

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Research interests and programs

Seismicity of Queensland

Seismicity of northeastern New South Wales

Controlled Source Seismology - crustal and upper mantle structure of the Tasman Fold Belt in Queensland.

Reservoir Induced Seismicity

Instrumentation Development

Intraplate Tectonics

Tectonics of a Passive Continental Margin

Seismic Risk in Northeastern Australia.

Summary of research work since 1978

SEISMICTY OF QUEENSLAND

Objectives: As little has been documented about the nature and level of seismic activity in Queensland, this project aims at documenting, relocating and calculating the various earthquake parameters related to all known earthquakes in Queensland. The period covers 1866 to the present. The ultimate aim is to produce a complete list and epicentral map for Queensland earthquakes in this period, and compile isoseismal maps for the many earthquakes for which isoseismal surveys have been conducted.

Approaches: The basic data set has been compiled from many sources. For the pre-instrumentation period (that is, before 1937 when the first seismograph was installed in Brisbane) 1866 to about 1940, most data are macroseismic and have

been taken from the regional newspapers. For the larger events during this period, in particular from 1909, instrumental data has been obtained from the RIV (Riverview, Sydney) seismograms. For the post 1937 period the data comprises both instrumental records and isoseismal reports.

Results: A paper entitled "The Seismicity of Queensland: 1866-1981" is currently in preparation. This encompasses a full list of epicentres and their seismic parameters, epicenral maps, descriptive catalogue of the major earthquakes and isoseismal maps.

SEISMICITY OF NORTHEASTERN NEW SOUTH WALES

Following seven earthquakes widely felt in this region (Kempsey 1979, Ashford 1980, Glen Innes 1981, Inverell 1982 (two), Glen Innes 1982 (two)) and reports of local felt "tremors" in the Glen Innes and Inverell areas over the past two years, a programme was initiated to undertake a preliminary study of the seismicity of the region. The study area covers the New England Fold Belt and the southern part of the Clarence - Moreton Basin in northeastern New South Wales. Three research papers have been completed. The results indicate what appears to be an upsurge in activity in the last three years in comparison to what has been reported for the last thirty to forty years. Although little can be said about causal relationships it does appear that the activity is primarily confined to the northern part of the Fold Belt (in the Texas - Woolamin Block). A microearthquake field experiment conducted in the Glen Innes region for three months in the 1981-82 summer indicates in this area the activity at the microearthquake level is quite low.

CONTROLLED SOURCE SEISMOLOGY:

This aspect involved long-range seismic refraction profiles to determine the structure of the crust and upper mantle in the Tasman Fold Belt (defined as that part of eastern Queensland east of the Great Dividing Range from North Queensland to the Queensland - New South Wales border). Data analyses are currently in progress on three major profiles in this region: in northeastern

Queensland (Greenvale to Goonyella); central Queensland Bowen Basin (Goonyella to Moura); southeastern Queensland (Moura to Gold Coast; including a detailed study in the Wivenhoe Dam region near Brisbane). Most of the field work has been completed and data analyses are currently in progress.

RESERVOIR INDUCED SEISMICITY:

A comprehensive project is in progress to study the induced seismicity related to the Wivenhoe Dam in southeast Queensland region. Begun in March 1977, this study has determined the level and nature of seismic activity in this region for the pre-impounding stage. Seventy-five microearthquakes have been located in the vicinity of the dam. These indicate stress release along the Eastern Border Fault adjacent to the dam and in the D'Aguilar block to the east. In addition, seismic refraction profiles to determine crustal structure and studies of the current state of tectonic stress of the region are in progress. It is planned to continue this surveillance project for the next five years during the post-impounding stage, both to determine any induced seismicity and to compare the pre- and post-impounding stages in relation to changes in local tectonic stress due to the presence of the Wivenhoe Reservoir. The results to date show that seismicity is indeed present at the microearthquake level with seventy-five events having occurred during the pre-impounding phase. These have included two ML about 4.0 earthquakes in the area (both felt by the local population) and a swarm of microearthquakes about 5 km downstream from the dam.

INSTRUMENTATION DEVELOPMENT

Many instruments, both for field recording and laboratory data processing, have been developed. These include telemetered seismic stations, microearthquake instruments, slow speed analogue tape recorders, assistance with recent instrumentation at Charters Towers, blast timing recorders and analogue and digital processing equipment for the controlled source seismology data.

INTRAPLATE TECTONICS:

TECTONICS OF A PASSIVE CONTINENTAL MARGIN:

SEISMIC RISK IN NORTHEASTERN AUSTRALIA:

These three catagories constitute the basic theses for our seismological research. Each of these will be considered as a part of the aforementioned specific projects. The intention is to provide a cohesive nature to the seismological projects and as data are obtained and interpretation forthcoming, such aspects will be discussed in the context of the particular area under study. All seismological research has been tailored to the International Lithosphere Project as it pertains to the Australian region.

Publications since 1978

RYNN, J.M.W., 1979: The operation of remote seismograph stations using satellite communication - A proposed research experiment. In "DOMSAT '79: A communications Satellite For Australia - Who Will Benefit? Papers and Proceedings of the First National Domestic Satellite Conference held February 20-23, 1979 at Australian National University, Canberra". (Ed. C. Deacon). The Centre for Continuing Education, Australian National University, Canberra Publication, 364-348.

HALES, A.L., MUIRHEAD, K.J. & RYNN, J.M.W., 1980: A compressional velocity distribution for the upper mantle. Tectonophysics, 63, 309-348.

DEACON, C.W. & RYNN, J.M.W., 1980: Scientific and environmental tele-services and the Australian communications satellite. ANZAAS Conference, 1980, Adelaide, Section 33 (Communication).

HALES, A.L., MUIRHEAD, K.J. & RYNN, J.M.W., 1980: Crust and upper mantle shear velocities from controlled sources. Geophys. J.R. astr. Soc., 63, 659-670.

RYNN, J.M.W., 1981: Earthquake activity in the Great Barrier Reef region. Environmental Engineering Conference, 1981, Townsville 8-10 July. The Institution of Engineers, Australia, Conference Publication No. 81/6, 57-63.

RYNN, J.M.W. & LYNAM, C.J., 1982: The seismicity of northeastern New South Wales (New England Fold Belt and southern portion of the Clarence-Moreton Basin) - A preliminary study. Proceedings of the symposium in honour of Emeritus Professor A.H. Voisey "The Geology of New England", Armidale, 5-9 July. 149-165.

RYNN, J.M.W. & WEBB, J.P., 1982: Final report to the Co-ordinator General's Department, State Government of Queensland for Phase 1 of the Wivenhoe Dam Seismic Surveillance Project March 1977 - April 1981, Report WDSSP-3. Dep. Geol. Miner. Univ. Qld. Seismology Gp. Report, 217 p.

RYNN, J.M.W. & LYNAM, 1982: The Kempsey earthquake of 6 September 1979. J. Proc. Roy. Soc. NSW., 115, 9-12.

P.W. Schmidt

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Research interests and programs

Palaeomagnetism, rock magnetism

Summary of research work since 1978

To develop methods which yield greater resolution to palaeomagnetism. The use of palaeomagnetism to delineate geological history with particular reference to the responses of different magnetic minerals.

Publications since 1978

SCHMIDT, P.W. & McDOUGALL, IAN, 1978: Reply: Palaeomagnetic and Potassium-Argon studies of the Tasmanian Dolerites. J. Geol. Soc., Aust., 25 (5,6), 366-367.

MORRIS, W.A., SCHMIDT, P.W. & ROY, J.L., 1979: An unconventional Proterozoic palaeomagnetic polar wander path for North America and its advantages. Phys. Earth Planet. Int., 19, 85-99.

EMBLETON, B.J.J., ROBERTSON, W.A. & SCHMIDT, P.W., 1979: A survey of magnetic properties of some rocks from northwestern Australia. CSIRO Investigation Report 129.

MORRIS, W.A., SCHMIDT, P.W. & ROY, J.L., 1979: An unconventional Proterozoic palaeomagnetic polar wander path for North America and its advantages - a reply. Phys. Earth. Planet. Int., 20, 71-73.

SCHMIDT, P.W. & EMBLETON, B.J.J., 1979: Mesozoic palaeomagnetic data from Australia. Tectonophysics, 60, 317-318.

EMBLETON, B.J.J. & SCHMIDT, P.W., 1979: Recognition of common Precambrian polar wander: a conflict with plate tectonics. Nature, 282, 705-707.

SCHMIDT, P.W., 1980: The palaeomagnetism of igneous rocks from the Belcher Islands, North West Territories, Canada. Can. J. Earth Sciences, 17, 807-822.

SCHMIDT, P.W. & CLARK, D.A., 1980: The response of palaeomagnetic data to Earth expansion. Geophys. J.R. astron. Soc., 61, 95-100.

SCHMIDT, P.W. & EMBLETON, B.J.J., 1981: Magnetic overprinting in southeastern Australia and the thermal history of its rifted margins. J. Geophys. Res, 86, 3998-4008.

SCHMIDT, P.W. & EMBLETON, B.J.J., 1981: A Geotectonic paradox: Has the Earth expanded? J. Geophys., 49, 20-25.

SCHMIDT, P.W., TAYLOW, G. & WALKER, P.H., 1982: Palaeomagnetic dating and stratigraphy of a Cainozoic lake near Cooma, N.S.W. J. Geol. Soc. Aust., 29, 49-53.

SCHMIDT, P.W., 1982: Linearity spectrum analysis of multicomponent magnetisations and its application to some igneous rocks from south eastern Australia. Geophys. J.R. astr. Soc., 70, 647-665.

MIDDLETON, M.F. & SCHMIDT, P.W., 1982: Palaeothermometry of the Sydney Basin. J. Geophys. Res., 87, 5351-5359.

BISHOP, P., HUNT, P. & SCHMIDT, P.W., 1982: Limits to the age of folding on the Lapstone Monocline, NSW - a palaeomagnetic study. J. Geol. Soc. Aust., 29, 319-326.

SCHMIDT, P.W. & EMBLETON, B.J.J., 1982: Comments on "Palaeomagnetism of upper Cretaceous volcanics and Nubian sandstones of Wadi Natash, SE Egypt and implications for the polar wander path for Africa in the Mesozoic" by Schult, A., Hussain, A.G. and Soffel, H.C. J. Geophys., 51, 150-151.

CLARK, D.A. & SCHMIDT, P.W., 1982: Theoretical analysis of thermo-magnetic properties, low temperature hysteresis and domain structure of Titanomagnetites. Phys. Earth. Planet. Int., 30, 300-316.

A. Siggins

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Research interests and programs

Application of seismic pulse and resonance techniques to determining rock condition.

Summary of research work since 1978

Applying dynamic testing methods to rock mass condition.

Publications since 1978

SIGGINS, A.F., 1979: Instrumentation and interpretation of a plate bearing test using anchor loading. Technical Report No. 82. CSIRO.

SIGGINS, A.F. & ENEVER, J.R., 1979: A laboratory simulation of the influence of defects on the dynamic response of a rectangular mine opening. Proc. 1979 ISRM Congress on Rock Mechanics, Switzerland, Vol. I, 293-300.

SIGGINS, A.F., 1981: Prediction of block resonance by modal-superposition. Technical Report No. 126 CSIRO.

SIGGINS, A.F. & HUNT, L., 1981: Some dynamic testing methods for rock samples and equivalent materials. Internal Report No. 39 CSIRO.

SIGGINS, A.F., 1981: A concentrated pressure pulse on a semi-infinite rock-like medium; a comparison between theory and dynamic finite element calculations. Technical Report No. 122 CSIRO.

SIGGINS, A.F., 1981: Vibrational response of coal mine roof. Abstract submitted to the ISRM, Melbourne 1982.

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Research interests and programs

Geomagnetism

Summary of research work since 1978

A joint participant in BMR program on geomagnetism.

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Research interests and programs

Earthquake seismology, particularly

- seismometry
- magnitudes
- focal mechanisms.

Summary of research work since 1978

Investigations of earthquake effects and compilation of isoseismal maps (for BMR Isoseismal atlas).

Compilation and investigations of focal mechanisms and acceleration recordings.

Publications since 1978

EVERINGHAM, I.B. & SMITH, R.S., 1979: Implications of fault-plane solutions for Australian Earthquakes on 4 July 1977, 6 May 1978, and 25 November 1978. BMR J. of Aust. Geol. & Geophys. 4, 297-301.

SMITH, R.S. & McEWIN A.J. 1980: Earthquake accelerograms and attenuation of seismic waves at Colong, NSW. BMR J. of Aust. Geol. & Geophys. 5, 63-66.

DENHAM, D., BOCK, G. & SMITH, R.S., 1982: The Appin (New South Wales) earthquake of 15 November 1981. BMR J. of Aust. Geol. & Geophys., 7, 219-223.

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Research interests and programs

Tectonomagnetism and earthquake prediction

Thermodynamics - thermal problems, and properties of earth materials

Anelasticity and attenuation of stress waves.

Summary of research work since 1978

1. Tectonomagnetism and Earthquake Prediction.

The hope that piezomagnetism would provide a viable basis for earthquake prediction has faded in the 15 years since serious work began and a reappraisal of fundamentals is in progress. A new mathematical method of seismomagnetic modelling has been developed to grade displacements to zero at the boundary of a fault plane, to avoid stress singularities that have been assumed implicitly in some earlier calculations. Seismomagnetic anomalies are found to be weaker and of more limited extent than previously estimated. A new series of laboratory measurements of the piezomagnetic effect is in progress to seek an explanation of the magnetic grain size effect that has been observed.

2. Thermodynamics - thermal problems and properties of earth materials.

A second-order elasticity theory has been developed, showing the necessity for a decrease in Poisson's ratio of any crystalline structure with pressure and yielding an improvement to the free-volume formulation of the Gruneisen parameter, . The free-volume relationship gives a unique high pressure equation of state for proportional to $(\text{density})^{-1}$, as may be appropriate for the lower mantle. A conclusion that the Earth is cooling, at a rate such that about 30% of the geothermal flux represents loss of residual heat, is found to be unavoidable. This has removed the need to postulate any radioactivity in the core to explain dynamo action.

3. Anelasticity and attenuation of stress waves.

Stress-strain loops of rocks are found to be elliptical at strain amplitudes of 10^{-6} or less. This is direct evidence of linearity of the loss mechanism and makes secure the linear theory of seismic wave attenuation, which specifies body wave dispersion. The linear damping of small amplitude stress waves is frequency dependent. Frequency independence and lower Q are characteristic of larger amplitude stress cycles at which internal friction appears to be dominated by grain boundary effects.

PUBLICATIONS SINCE 1978

DAVIS, P.M., STACEY, F.D., ZABLOCKI, C.J. & OLSON J.V., 1979: Improved signal discrimination in tectonomagnetism: discovery of a volcano-magnetic effect on Kilauea, Hawaii. Phys. Earth Planet. Int., 19, 331-336.

DAVIS, P.M., OLSON, J.V., ZABLOCKI, C.J. & STACEY, F.D., 1979: Improved signal discrimination in tectonomagnetism: discovery of a volcano-magnetic effect on Kilauea, Hawaii. (Abstract) E.O.S. (Trans. Am. Geophys. Un.) 58, 733.

BRENNAN, B.J. & STACEY, F.D. 1979: A thermodynamically based equation of state for the lower mantle. J. Geophys. Res., 84, 5535-5539.

FALZONE, A. & STACEY, F.D., 1980: Second order elasticity theory: explanation for the high Poisson's ratio of the inner core. Phys. Earth Planet. Int. 21, 371-377.

STACEY, F.D., TUCK, G.J., HOLDING S.C., MAHER, A.R. & MORRIS, D., 1981: Constraint on the planetary scale value of the Newtonian gravitational constant from the gravity profile within a mine. Phys. Rev. D23, 1683-1692.

STACEY, F.D., 1980: The cooling Earth: a reappraisal. Phys. Earth Planet. Int. 22, 89-96.

STACEY, F.D., 1981: A thermodynamic approach to equations of state and melting at mantle and core pressures. In R.J. O'Connell and W.S. Fyfe (editors), Evolution of the Earth (American Geophysical Union), 264-271.

STACEY, F.D., 1981: Cooling of the Earth - a constraint on paleotectonic hypotheses. In R.J. O'Connell and W.S. Fyfe (editors), Evolution of the Earth (American Geophysical Union), 272-276.

FALZONE, A.J. & STACEY, F.D., 1981: Second order elasticity theory: an improved formulation of the Gruneisen parameter at high pressures. Phys. Earth Planet. Int., 24, 284-290.

STACEY, F.D., 1981: Interpretation of adiabatic decompression measurements of the Gruneisen parameter. J. Geophys. Res., 86 1039-1041.

STACEY, F.D., PATERSON, M.S. & NICOLAS, A., (editors), 1981: Anelasticity in the Earth (American Geophysical Union 1981), 122 pp.

TURNER, G.J. & STACEY, F.D., 1981: Frequency dependence of Q for rock stressed near to breaking point. In F.D. Stacey, M.S. Paterson and A. Nicolas (editors), Anelasticity in the Earth (American Geophysical Union 1981), 83-85.

STACEY F.D., 1981: A thermodynamic approach to problems of the Earth's interior. Int. Union of Geodesy and Geophysics Chronicle, 149, 117-129.

STACEY, F.D., BRENNAN, B.J. & IRVINE, R.D., 1981: Finite strain theories and comparisons with seismological data. Geophys. Surveys, 4, 189-232.

STACEY, F.D. & TUCK, G.J., 1981: Geophysical evidence for non-Newtonian gravity. Nature, 292, 230-232.

STACEY, F.D., 1981: Variability of the Earth's rotation. Nature, 289, 750.

FALZONE, A.J. & STACEY, F.D., 1982: Measurements of thermal expansions of small mineral crystals. Phys. Chem. Minerals, 8, 212-217.

JIN-QI HAO, HASTIE, L.M., & STACEY, F.D., 1982: Theory of the seismomagnetic effect: a reassessment. Phys. Earth Planet. Int. 28 129-140.

JIN-QI HAO, PARRY, L.G., TUCK, G.J., & STACEY, F.D., 1982: The piezomagnetic effect in rocks: a comparison of measurements in high and low fields. Phys. Earth Planet. Int., 29, 173-182.

WEBB, S.L. & STACEY, F.D., 1982: A simple demonstration of the frequency dependences of elastic moduli and the damping of stress waves at seismic frequencies. Bull. Aust. Soc. Expl. Geophys. 13, 23-25.

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Research interests and programs

Seismicity of South Australia

Microearthquakes in the Flinders Ranges

Computerised seismic data acquisition and processing systems

Crustal structure beneath Adelaide Geosyncline from quarry blasts

Summary of research work since 1978

Earthquake monitoring in South Australia

The South Australian seismic network, operated by the Physics Department of the University of Adelaide, has grown steadily from its original three stations in 1963 to twelve in 1979. The network now extends to the south-east of the State (to monitor seismic activity possibly associated with volcanism in the region), and the density of the network has been increased around the northern tip of Spencer Gulf (to study the microseismicity of the seismically active Adelaide Geosyncline adjacent to this important industrial area). Recording in the latter region has been augmented by microearthquake surveys performed in the area using an additional seven stations comprised of portable equipment.

Computerised seismic data processing system

The greatly increased volume of data now recorded on the S.A. seismic network prompted the development of a computerised seismic data system. The system is based around a Data General Nova minicomputer, including dual floppy disks and a fast printing terminal, with additional peripherals developed as part of the project. Software comprises an integrated, interactive system of seismic analysis routines covering all of the data processing needs of the

network, from performing station calibrations and maintaining up-to-date station data, through the determination of locations and magnitudes of local earthquakes and the needs of microearthquake survey data processing, to the retrieval and display of earthquake statistics from an archived data base. In developing the routines, some new location methods were employed, and a duration-based magnitude scale was developed and incorporated.

Development of Digital Seismic event recorders

The computerized data processing system extends to the acquisition of digital seismic data in the field, using a microprocessor-controlled digital seismic event recorder designed as part of the system. The event recorder is battery powered, recording data on digital cassette tape. The software maintains maximum dynamic range by controlling the amplifier gain. Events are selected tentatively on the basis of amplitude, and are confirmed by tests based on total signal duration and principal frequency component before any data are committed to tape. Cassettes can be read directly into the Nova computer, digitized waveforms can be displayed, and phases interactively selected and submitted for processing by the analysis routines. The computerized system (with the exception of the event recorder itself) has been used in the analysis of all local earthquakes and microearthquake surveys in South Australia since the beginning of 1978.

Refraction investigations of crustal structure in the Adelaide Geosyncline using quarry blasts

Explosions at two large open cut mines (Leigh Creek and Iron Baron) were used as sources of seismic energy to record along two linear profiles parallel and approximately transverse to the axis of the Adelaide geosyncline in South Australia. Records at approximately 120 sites were obtained out to distances of

the order of 350 km with Kinemetrics PS-IA portable seismographs, using smoked paper and a recording speed of 4 mm/s. Times of blasting were determined from records at some of the permanent stations of the University of Adelaide seismograph network. Station spacing was normally 5 km but at large distances from the source this increased to the order of 10 km.

The simplest model of the crust consistent with the observed travel times comprises two essentially homogeneous layers overlying the mantle. The average P wave velocities in the upper and lower crustal layers are 5.94 km/s and 6.46 km/s, with the boundary between the layers at approximately 18 km and possibly 8 km below Eyre Peninsula. Although such a division has been found in other parts of Australia, none of the earlier studies in S.A. found evidence for such a discontinuity or velocity gradient. The P wave velocity in the upper mantle is 7.97 km/s and the mean thickness of the crust is 39 km. Both the intermediate and Moho "discontinuities" may vary by up to 5 km from their mean depths. Shear waves have velocities of 3.43 and 4.45 km/s in the upper crustal layer and the upper mantle, respectively.

Publications since 1978

McCUE, K.F. & SUTTON, D.J. 1979: South Australian earthquakes during 1976 and 1977. J. Geol. Soc. Aust. 26, 231-236.

SHACKLEFORD, P.R. & SUTTON, D.J. 1981: A first interpretation of crustal structure in the Adelaide Geosyncline in South Australia using quarry blasts. J. Geol. Soc. Aust. 28, 491-500.

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Research interests and programs

The nature of gravity.

Summary of research work since 1978

Publications since 1978

STACEY, F.D. & TUCK, G.T., 1981: Geophysical evidence for non-Newtonian gravity. Nature, 292, 230-232.

JIN-QI HAO, PARRY, L.G., TUCK, G.J. & STACEY, F.D., 1982: The piezomagnetic effect in rocks: a comparison of measurements in high and low fields. Phys. Earth Planet. Int., 29, 173-182.

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Research interests and programs

Earthquake Seismology

Summary of research work since 1978

Seismic surveillance of large hydro-electric storages for load-influenced siesmicity. Calculation of seismic risk.

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Research interests and programs

Crustal structure in Australia and Antarctica from gravity and magnetic anomalies and explosion seismology.

Measurement of intraplate Recent crustal movement, and its relation to and earthquake seismology plate movements, and Cainozoic tectonics.

Publications since 1978

WELLMAN, P., 1981: Crustal movement determined from repeat surveying - results from southeastern and southwestern Australia. J. geol. Soc. Aust. 28, 311-321.

WELLMAN, P. & WILLIAMS J.W. 1982 The extent of Archean and Late Proterozoic rocks under the ice cap of Princess Elizabeth Land, Antarctica, inferred from geophysics. BMR J. Geol. Geophys., 7, 213-218.

WELLMAN, P., 1982. Australian seismic refraction results, isostasy and altitude anomalies. Nature, 298, 838-841.

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Budoora, Victoria, 3083

Research interests and programs

Main research interest is earthquake seismology

Explosion seismology used to develop lithospheric models.

Publications since 1978

GIBSON, G., WESSON, V. & CUTHBERTSON, R., 1981: Seismicity of Victoria to 1980. J. Geol. Soc. Aust., 28, 341-356.

C. Wright

Research School of Earth Sciences

Australian National University, ACT

Research interests and programs

Earthquake Seismology

Explosion Seismology

Summary of research work since 1978

1. The Structure of the Deep Mantle

The P-wave velocity structure of the earth's mantle between depths of 1000 km and the core-mantle boundary is being investigated using earthquake data recorded at the Warramunga array and at temporary linear networks of seismographs deployed across Australia. The major objective is to determine whether possible triplications in the travel-time curve at distances of about 50° and 87° really are produced by rapid increases in P-wave velocity at depths of about 1250 km and 2730 km. Previous evidence for the existence of these two anomalies has come from slowness measurements at both the Warramunga array in Australia and the Yellowknife array in Canada.

2. The Sharpness of Mantle Discontinuities

The sharpness of upper mantle discontinuities is being studied by searching for P to SV or SV to P conversions for both short and long-period seismograms. The first step in this recently started project is an examination of possible P to SV conversions for earthquakes at distances greater than 50° recorded on the horizontal-component seismograms at the Warramunga array.

Publications since 1978

WRIGHT, C. & LYONS, J.A., 1979: The identification of radial velocity anomalies in the lower mantle using an interference method, Phys. Earth Planet. Int., 18, 27-33.

WRIGHT, C. & LYONS, J.A., 1981: A method of searching for radial velocity anomalies in th lower mantle using interfering signals. Pure Appl. Geophys., 119, 119-136.

WRIGHT, C. & LYONS, J.A., 1981: Further evidence for radial velocity anomalies in the lower mantle. Pure Appl. Geophys., 119, 137-162.

WRIGHT, C. & HOY, D., 1981: A note on pulse broadening and anelastic attenuation in near-surface rocks. Phys. Earth Planet. Int., 25, P1-P8.

WRIGHT, C. & HARRIS, S.J., 1981: Errors in travel times measured on paper seismograms. Geophys. J. Roy. Astron. Soc., 67, 565-576.

WRIGHT, C., 1981: Comments on "Apparent velocity measurements for the lower mantle from a wide aperture array" by L.J. Burdick and Christine Powell. J. Geophys. Res., 86, 11, 927-11, 930.

SEISMOGRAPH STATIONS IN OPERATION IN CONTINENTAL AUSTRALIA

DURING 1982

CODE	STATION NAME	LAT. S	LON. E	ELEV.	COMP.	OPERATOR
ABE*	ABERFELDY	37.719	146.389	549	SPZ	PIT
ADE	ADELAIDE	34.967	138.714	655	WWSS	UA
ASPA	ALICE SPRINGS	23.667	133.901	600	ARRAY	BMR
AVO	AVON	34.376	150.615	532	SPZ	ANU
AWMG*	MT GOLEGUMMA	24.046	151.316	125	SPZ	GSQ
BAL	BALLIDU	30.606	116.707	300	SPZ	BMR
BDDM*	BOONDOOMA DAM	26.112	151.443	320	SPZ	GSQ
BFD	BELLFIELD	37.177	142.545	235	SPZ	BMR
BFGC*	GL'DON CROSSING	20.614	147.161	160	SPZ	GSQ
BFMG*	MT GRAHAM	20.614	147.061	160	SPZ	GSQ
BFGR*	GLENROY	20.549	147.105	160	SPZ	GSQ
BRS	BRISBANE	27.392	152.775	525	3 COMP	UQ
BWA*	BOOROWA	34.425	148.751	656	SPZ	ANU
CAH	CASTLE HILL	34.647	149.242	700	SPZ	ANU
CAN	CANBERRA	35.321	148.999	650	SPZ	ANU
CBR	CABRAMURRA	35.943	148.393	1537	SPZ	ANU
CNB	CANBERRA OBSERVATORY	35.315	149.363	853	SPZ	BMR
CLV	CLEVE	33.691	136.496	238	SPZ	UA
COO	COONEY	30.578	151.892	650	SPZ	BMR
CTA	CHARTERS TOWERS	20.088	146.255	357	WWSS	UQ
DRT*	DARTMOUTH	36.583	147.492	950	SPZ	ANU

EDO*	ENDILLOC	32.322	138.048	300	SPZ	UA
GVL	GREENVALE	37.619	144.901	188	SPZ	PIT
HKN*	HAWKSNEST	30.012	135.186	171	SPZ	UA
HTT	HALLETT	33.430	138.922	708	SPZ	UA
ILN	ISLAND LAGOON	31.393	136.870	137	SPZ	UA
ISQ	MOUNT ISA	20.715	139.553	500	SPZ	BMR
IVN	INVERALOCHY	34.965	149.667	650	SPZ	ANU
JEN*	JEERALANG	38.351	146.419	330	SPZ	PIT
JNL	JENOLAN	33.826	150.017	829	SPZ	ANU
KGD*	KANGAROO GROUND	37.699	145.269	80	SPZ	ANU
KHA	KHANCOBAN	36.214	148.129	435	SPZ	ANU
KLB	KELLERBERRIN	31.578	117.760	300	SPZ	BMR
KLG	KALGOORLIE	30.783	121.458	360	SPZ	BMR
KNA	KUNUNURRA	15.750	128.767	150	SPZ	BMR
LER	LERIDA	34.934	149.364	940	SPZ	ANU
LIL*	LILYDALE	37.694	145.342	80	SPZ	PIT
MAL*	MARSHALL SPUR	37.748	146.291	1076	SPZ	PIT
MBL	MARBLE BAR	21.160	119.833	200	SPZ	BMR
MEG	MEANGARA	35.101	150.037	712	SPZ	ANU
MEK	MEEKATHARRA	26.613	118.545	520	SPZ	BMR
MGR*	MT. GAMBIER	37.728	140.571	190	SPZ	UA
MIC*	MOUNT ERICA	37.903	146.359	805	SPZ	PIT
MOO	MOORLANDS	42.442	146.191	325	SPZ	TAS
MTN	MANTON	12.847	131.130	80	3 COMP	BMR
MUN	MUNDARING	31.978	116.208	253	WWSS	BMR
NAU	NANUTTARRA	22.544	115.500	80	SPZ	BMR
NBK*	NECTAR BROOK	32.701	137.983	180	SPZ	UA
NWAO	NARROGIN	32.927	117.233	265	SRO	BMR
PAT*	PLANE TRACK	37.357	146.456	771	SPZ	PIT
PNA	PARTACOONA	32.006	138.165	180	SPZ	UA

PNH*	PANTON HILL	37.635	145.271	180	SPZ	PIT
Q08*	SCRUB CREEK	27.018	152.418	110	SPZ	UQ
Q16*	GRANDCHESTER	27.626	152.446	160	SPZ	UQ
Q10*	PINE MT.	27.536	152.736	35	SPZ	UQ
Q17*	PLAINLAND	27.606	152.417	160	SPZ	UQ

Q01 - Q17 ARE AN ARRAY OF STATIONS NEAR THE WIVENHOE DAM SITE

Q08,10,16 & 17 DEFINE THE APERTURE OF THE ARRAY

RIV	RIVERVIEW	33.829	151.158	21	WWSS	BMR-R
RPA*	ROOPENA	32.725	137.403	95	SPZ	UA
SAV	SAVANNAH	41.721	147.189	180	SPZ	TAS
SBR*	SOUTH BLACKRANGE	35.425	149.533	1265	SPZ	ANU
SFF	SHEFFIELD	41.338	146.308	213	SPZ	TAS
SPK	SCOTTS PEAK	43.038	146.275	425	SPZ	TAS
STG	STRATHGORDON	42.751	146.053	350	SPZ	TAS
STK	STEPHENS CREEK	31.882	141.592	213	SPZ	BMR
SVR*	SAVAGE RIVER	41.489	145.211	360	SPZ	TAS
TAO	TALBINGO	35.596	148.290	570	SPZ	ANU
TAU	TASMANIA UNIVERSITY	42.910	147.321	132	WWSS	TAS
TOM*	THOMSON	37.810	146.348	941	SPZ	ANU
TOO	TOOLANGI	37.572	145.490	604	3 COMP	BMR
TRR	TARRALEAH	42.304	146.450	579	SPZ	TAS
UMB	UMBERATANA	30.240	139.128	610	SPZ	UA
WAM	WAMBROOK	36.193	148.883	1290	SPZ	ANU
WBN	WARBURTON	26.140	126.578	457	SPZ	BMR
WER	WEROMBI	33.950	150.580	226	SPZ	ANU
WKA*	WILLALOOKA	36.417	140.321	40	SPZ	UA
WRG*	WOOMERA	31.105	136.763	168	SPZ	UA
WRA	WARRAMUNGA ARRAY	19.944	134.341	360	ARRAY	ANU
YOU	YOUNG	34.278	148.382	503	SPZ	ANU

OPERATOR CODES

ANU - RESEARCH SCHOOL OF EARTH SCIENCES, AUSTRALIAN NATIONAL UNIVERSITY

BMR - BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GSQ - GEOLOGICAL SURVEY OF QUEENSLAND

PIT - PHILLIP INSTITUTE OF TECHNOLOGY

TAS - UNIVERSITY OF TASMANIA

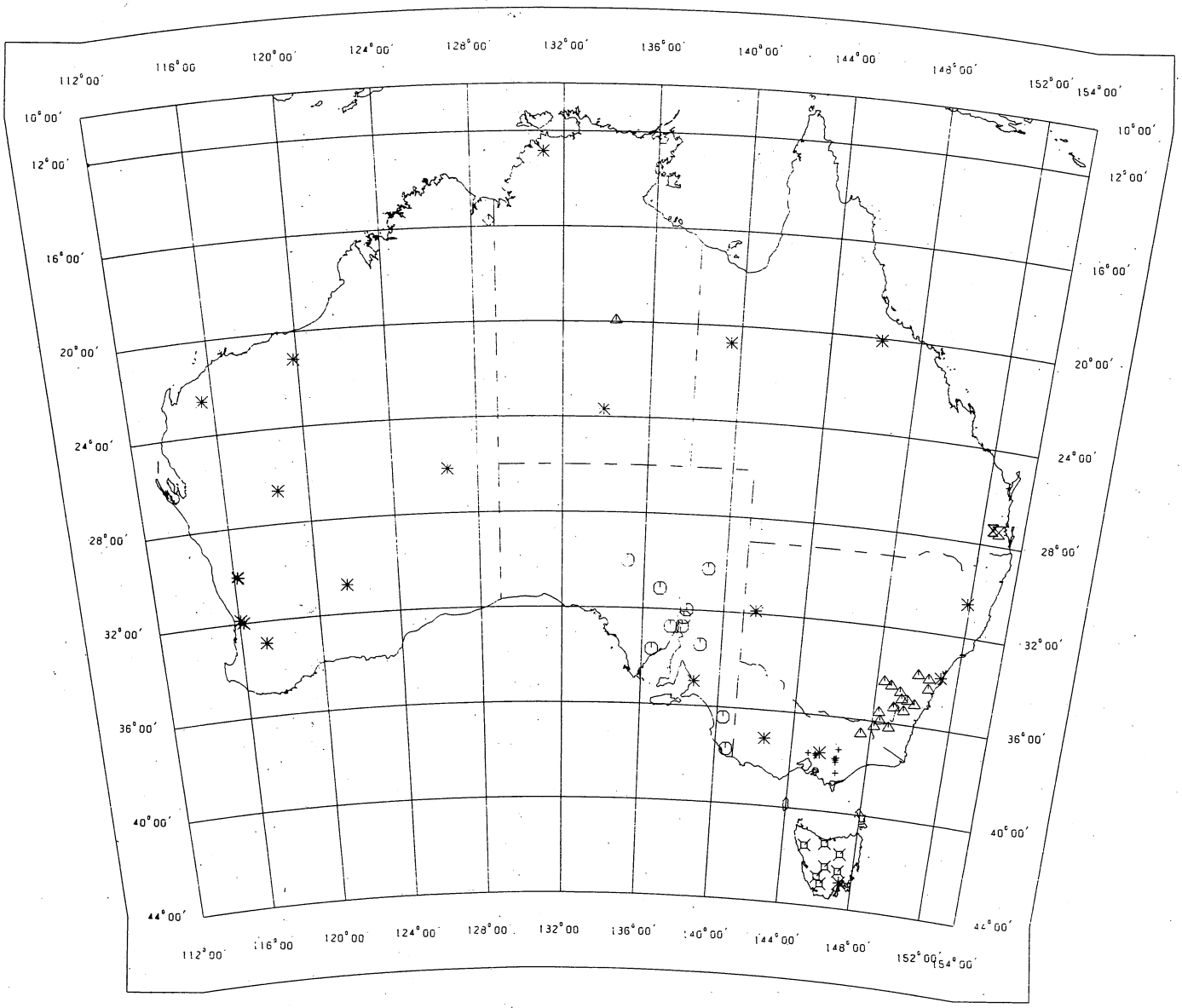
UA - UNIVERSITY OF ADELAIDE

R - RIVERVIEW COLLEGE

* - UNOFFICIAL STATION CODE

AUSTRALIA

SCALE 1:30000000



AUSTRALIAN NATIONAL SPHEROID
SIMPLE CONICAL PROJECTION
WITH TWO STANDARD PARALLELS
AT 18°00' AND 36°00' SOUTH

AUSTRALIA

SEISMOGRAPH STATIONS 1982

✳ STATIONS OPERATED BY BMR OR JOINTLY WITH ANOTHER ORGANIZATION

○ △ ⌑ + ⧖ ◇ STATIONS OPERATED BY ADELAIDE UNIVERSITY, AUSTRALIAN NATIONAL UNIVERSITY, UNIVERSITY OF TASMANIA, PRESTON INSTITUTE OF TECHNOLOGY, UNIVERSITY OF QUEENSLAND AND W.A. PUBLIC WORKS DEPT