hydrocarbon leakage effects. This proprietary system known as FLUOROSCAN uses a short high intensity UV pulse to detect at high sensitivity fluorescence in oil coated aerosols, surface slicks and water column dispersions of oil. The technology is an outgrowth of an earlier laser system developed for pollution monitoring that has been used extensively in offshore surveys. A new high speed electronic switching technique is employed to separately discriminate for water and aerosol effects. Survey speeds are anticipated to be almost double those of AIRTRACE since the drag of the aerosol sampling equipment is eliminated and a faster aircraft can be employed. A further potential advantage of the FLUOROSCAN equipment is a relatively high degree of weather tolerance which should be a very important factor in some areas of the world.

In addition to measuring the primary effects of hydrocarbon leakage with these geochemical systems, a secondary phenomenon relating to the development of anomalous susceptibility along sedimentary leakage pathways can be simultaneously monitored with high sensitivity aeromagnetic equipment. This integration of airborne geochemical methods with airborne geophysics appears attractive but is still under evaluation.

The full value of these systems can only be properly evaluated when there has been extensive followup by drilling. At the present time however it would appear that there is a general occurrence of hydrocarbon leakage activity in the form of clusters in areas that are either productive or potentially productive. Conversely regions devoid of mature source rocks are believed to exhibit very little geochemical leakage. If this relationship is substantiated, then these rapid reconnaissance airborne techniques can be used as a followup to regional seismic surveys or as a means of directing primary seismic coverage. The ultimate objective is to identify those seismic prospects that are closely associated with dynamic oil and gas seepage.

Overland adaptations of these airborne geochemical and geophysical methods are currently under consideration and the results of extensive surface research on primary and secondary leakage effects as they may relate to the airborne techniques are very encouraging. The outcome of this work will be reported.

R = Registered trademark of Barringer Resources Inc.

THE AUSTRALIAN GEOMAGNETIC REFERENCE FIELD—ITS BASIS AND APPLICATIONS

C. E. Barton, P. L. McFadden and A. J. McEwin

Introduction

The magnetic field at the surface of the Earth, when averaged over a sufficient interval of time to remove transient variations (nominally 1 year), consists principally of a contribution originating from the Earth's core, called the 'main field', and a lesser contribution arising from permanent and induced magnetization of the crust. The International Geomagnetic Reference Field (IGRF) is the internationally adopted set of spherical harmonic models which are intended to represent the main (core) field and its secular variation. Regional models of the geomagnetic field represent a combination of the main field and the broad-scale crustal field. They are used as aids for navigation, surveying, certain military applications, geophysical exploration, determination of sea-floor ages and spreading history, and in studies of geomagnetic phenomena.

Due to the paucity of observations in the southern hemisphere, the IGRF for the Australian region is relatively poorly constrained, being dependent on a high proportion of remote observations. As a consequence, the IGRF is not a particularly good representation of the magnetic field over Australia. Ground measurements of total field, smoothed to remove effects of local anomalies, typically show departures from corresponding IGRF values of up to a few hundred nanotesla. Differences between the regional model for 1980 (BMR/80) and IGRF 1980 are illustrated in Fig. 1. IGRF 1980 was a particularly accurate model of the field because it included a large amount of MAGSAT data. Fits to regional models would not normally be as good as illustrated in Fig. 1. Since by definition the IGRF is the best representation of the Earth's main field in any region it is not intended, and cannot be expected to give a very close match to the actual field observed.

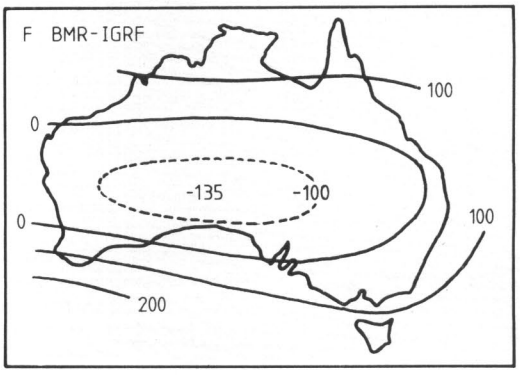

FIGURE 1
Contoured differences in total field between the BMR regional model for 1980, BMR/80 and IGRF 1980.

The situation regarding secular variation is somewhat different. Since the regionally observed secular variation is essentially the secular variation of the main field, there should be agreement with the IGRF secular variation model. Fig. 2 shows the distribution of differences in annual change in total field for 1985 at repeat stations and observatories in the Australian region (Fig. 3) and corresponding values for IGRF 1985. Clearly IGRF values are systematically lower (more negative) than the regional observations, and the distribution peaks at about 10 nT/yr. Such differences become substantial as they accumulate over many years.

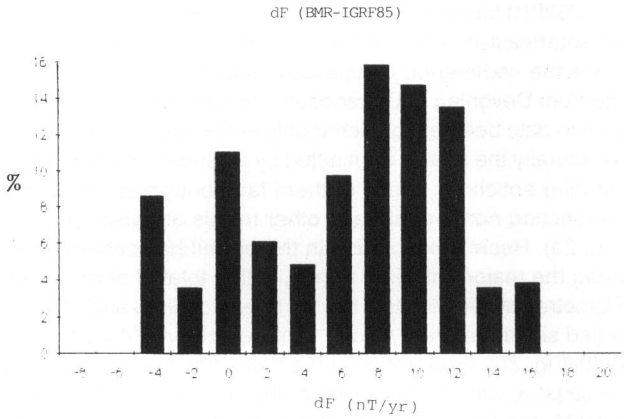

FIGURE 2

Distribution of differences between the annual change of total field (dF in nT/yr) for epoch 1985.0 at 80 repeat stations and observatories and corresponding IGRF values. The ordinate is the percentage of stations with differences in dF in successive 20 nT/yr intervals centred about the values given on the abscissa.

IGRF secular variation models are based essentially on observatory data. Observatories certainly provide the highest quality secular variation information, but in the Australian region their average separation is very large (approximately 2600 km). By combining observatory data with 'first-order' observations at repeat stations (i.e. observations designed to eliminate diurnal and transient disturbances) a much better regional secular variation model can be obtained. Charts and models of components of the geomagnetic field and their annual changes in the Australian region have been prepared by BMR at approximately 5-yearly intervals since epoch 1942.5, with the exception of 1975.0 (Table 1). Models for 1970 onwards have been developed principally to show the secular variation of the field. The observatory and repeat station data set used for these models is too small to provide a good representation of the regional field itself. The models are appropriate for reducing survey data to a common epoch, but are not adequate as reference models for detrending aeromagnetic and marine magnetic survey data, or for investigations into long wavelength magnetic anomalies.

By analogy with the IGRF, a suite of reference field models in standard numerical form is being developed for the Australian region—the 'Australian Geomagnetic Reference Field' (AGRF). The AGRF for 1985 has been designed to preserve the main field information in IGRF 1985 and take advantage of the versatility of orthogonal functions for modelling the regional component. All data were reduced to epoch 1985.0 by subjective extrapolation of secular variation trends. Corresponding values of IGRF 1985.0 were then subtracted, and the residuals modelled by rectangular harmonic analysis to obtain a set of coefficients representing

FIGURE 3

Magnetic observatories and repeat stations in the Australian region. Toolangi has been replaced by Canberra as the principal Australian observatory. Since 1985 Toolangi has been operated only as a variometer station.

Table 1.
Charts of the geomagnetic field and its secular variation in the Australian region produced by BMR.

Epoch	Comp[1].	Survey year(s)	Stns[1]	Charts	Author(s)
1942.5	D	1911–1939	45	D[2]	J. M. Rayner
1950.5	D	1944–1945	47	D	W. M. Holmes
1955.5	D	1952	51	D	F. W. Wood, I. B. Everingham
1957.5	DHI	1952–1957	51	DHIZF[3]	W. D. Parkinson, R. Curedale
1960.5	DHZ/I	1952–1957	51	D	W. D. Parkinson
1965.0	DHZ/F	1959–1964	58	D	J. Van der Linden
1970.0	DHF	1966–1970	81	All[4]	D. M. Finlayson
1980.0	DHF	1978–1979	71	All[5]	A. J. McEwin, P. M. McGregor & G. R. Small
1985.0	DHF	1981–1985	82	All[6]	A. J. McEwin, C. E. Barton & P. L. McFadden

[1]number of observatories plus repeat stations used to determine the secular variation;
[2]based on the initial set of 450 field stations, including the 45 repeat stations;
[3]incorporates a large amount of additional field survey data;
[4]based on combination of cubic spline fitting and hand contouring, incorporates some second-order and third-order survey data and is continuous with the New Zealand model for 1970.0;
[5]based on 4th degree polynomial fits to the observatory plus repeat station data only;
[6]based on rectangular harmonic analysis of observatory plus repeat station data only.

the potential of the residual field. The regional field at any point is a recombination of the residual and main fields synthesised from the two sets of harmonic coefficients. This technique is computionally efficient and permits flexibility in the choice of smoothing required of the model by appropriate truncation of the series of coefficients. The secular variation model for AGRF 1985 is based on the regional secular variation data only. AGRF 1985 is being made available as a FORTRAN software package.

The residual regional field component of AGRF 1985 still suffers from the limited size of the database (observatories and repeat stations only). Hence for removing trend surfaces from airborne and marine magnetic survey data to obtain magnetic anomalies, AGRF 1985 should be truncated to remove the residual regional field entirely. This is equivalent to using IGRF 1985, extended to later epochs using the regional secular variation model.

AGRF 1985 is an intermediate step in the development of retrospective AGRF models which incorporate a comprehensive analysis of all available regional field information—from land, marine, airborne and satellite surveys. These models will define the long wavelength magnetic anomaly structure of the continent, and will provide the basis for levelling adjustments to individual magnetic surveys used to assemble the 'Magnetic Map of Australia'. AGRF 1990 will incorporate this information.

SEISMIC ASPECTS OF RECENT OIL DISCOVERIES IN THE BODALLA BLOCK, COOPER/EROMANGA BASINS, QUEENSLAND

J. A. Bauer and P. L. Harrison

Introduction

ATP 269P(1) lies in the central Eromanga Basin and straddles the southeastern edge of the northern Cooper Basin (Fig. 1). While the sedimentary sequence includes rocks ranging in age from Devonian to Cretaceous, commercial hydrocarbons have to date been encountered only in the Jurassic sequence. Structurally the area is dominated by a series of northwesterly trending anticlines, many of them fault-bounded, but lesser intersecting north–south and other trends are also apparent (Fig. 2a). Recent exploration in the permit has concentrated along the major anticlinal trends, with a total of almost 5000 kilometres of seismic data having been acquired and 23 wells drilled since the present joint venture acquired the permit in 1980 (Fig. 2b). Exploration in the block has been moderately successful, with the discovery of the Bodalla South Oil Field in 1984, the Kenmore and Glenvale Oil Fields in 1985, and the Black Stump Oil Field in 1986. This represents an exploration success ratio of 1 in 2.75. Of the twelve appraisal wells drilled, ten have been completed as oil wells, representing an appraisal success ratio of 1 in 1.2.

Fundamental to the success of both exploration and appraisal drilling is the predictive power of the seismic method. The objective of this paper is to put into perspective the expectations held for the seismic method in the Bodalla Block, how it has measured up, and the continuing attempts to bridge the gap.

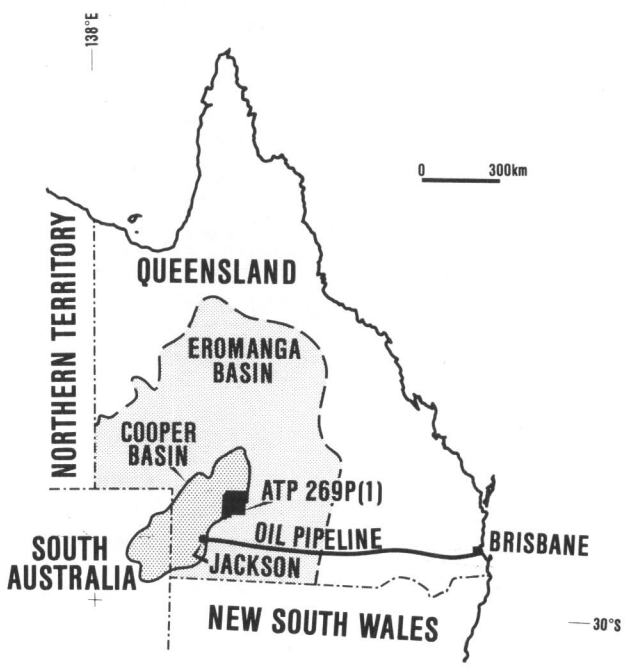

FIGURE 1
Locality map.