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for: CONDOR OIL INVESTMENTS PTY LTD

by: Malcolm Bendall
MANAGING DIRECTOR

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INTRODUCTION:

THE YEARS EXPLORATION INITIATIVES HAVE PAID OFF WITH THE BEGINNING OF THE LONG AWAITED AGSO PROJECT PLUS THE BRUNY ISLAND STRATIGRAPHIC HOLE IN NOVEMBER 1994, AND THE RELEASE BY THE C.S.I.R.O. OF THE RESULTS OF ITS 2 YEAR STUDY OF THE TASMINITES OIL SHALE.

THE STRATIGRAPHIC HOLE IS BEING DRILLED AT THE TIME OF WRITING THIS REPORT CONTINUING ON FROM THE 81 METRE 5½" PRE COLLAR HOLE WITH NQ SIZE CORING. THE HOLE COULD NOT BE COMPLETED IN 1994 DUE TO AN UNEXPECTED OUTBREAK OF GAS WHICH UPON TESTING PROVED TO BE A SAFE NON-FLAMABLE GAS.

THE COMPANY CANNOT UNDERSTAND, ESPECIALLY DUE TO THE FACT THAT IT IS DRILLING THE HOLE, ITS NEED TO JUSTIFY ANYTHING TO KEEP ITS LICENCES. THE REASON FOR THE SCHEDULE WAS TO ENSURE THE HOLE WOULD BE DRILLED: I SUGGEST THE PROOF IS IN THE PUDDING AND THE DEPARTMENT HAS LOST ITS WAY IN ITS OWN BUREAUCRATIC FOREST AND CAN'T SEE THE DRILL RIG FOR THE PREJUDICES IT HAS. SHITTIM 1 IS A HOLE VITAL TO THE AGSO 3 MILLION DOLLAR EXPENDITURE, AS IT WILL SUPPLY THE ONLY DOWN HOLE SEISMIC SHOT ESSENTIAL IF DATA COLLECTED ONSHORE IS TO BE PROCESSED.

WORK COMPLETED

TWO PRE-COLLAR HOLES, SHITTIM 1 AND GILGAL 1 HAVE BEEN COMPLETED AND ARE REPORTED UPON IN APPENDIX 6. CONDOR HAS CONDUCTED ITS NORMAL CHECKING OF REPORTED SEEPAGES WITHOUT RESULT. THE C.S.I.R.O. REPORT ON THE TASMINITES (APPENDIX 1) CLEARLY VERIFIES PREVIOUS WORK UPON WHICH GERRY CARNE BASED HIS ASSESSMENT THAT "THE TASMINITES OIL SHALE SHOULD BE MATURE ENOUGH TO GENERATE LARGE VOLUMES OF HYDROCARBONS OVER MUCH OF CENTRAL TASMANIA".

THE C.S.I.R.O. ALSO PRODUCED A REPORT (APPENDIX 2) DETAILING GAS SAMPLES TAKEN FROM THE TWO PRE-COLLAR HOLES, SHITTIM 1 AND GILGAL 1. AGSO ANALYSED THESE AS WELL AS TWO OTHER SAMPLES. AGSO'S PROJECT IS DEFINED IN APPENDIX 3.

DAVID LEAMAN PRODUCED THE PROGNOSIS FOR THE STRATIGRAPHIC HOLE (APPENDIX 4) AND TED McNALLY PRODUCED DRILLING SPECIFICATIONS FOR THE HOLE, (APPENDIX 5) AS WELL AS OTHER ADVICE. AS STATED, THE HOLES HAD THERMAL ANOMALIES AND AS STATED IN APPENDIX 2, SOME INDICATION OF BASS STRAIT TYPE AND MIDDLE EAST TYPE OILS, THE SOURCE OF WHICH HAS NOT YET BEEN DETERMINED.

TO CONTINUE THE STRATIGRAPHIC DRILL HOLE, SHITTIM 1, TO 1000 METRES, A DRILLER SUCH AS IS STATED BY APPENDIX 7 HAS BEEN CONTRACTED.

TRIAL HARBOUR MINING COMPANY HAS PROPOSED A 50% INTEREST IN THE LICENCES (FARM-IN AGREEMENT) AND A RESPONSE FROM THE BOARD OF CONDOR OIL INVESTMENTS CAN ONLY BE INITIATED AFTER A FULL MEETING OF UNIT/

SHAREHOLDERS; THE CURRENT HOLIDAY PERIOD SEEING THE COMPANY ACCOUNTANT AND SOLICITOR BOTH AWAY.
TRIAL HARBOUR MINING COMPANY IS CONTINUING DRILLING THE HOLE UNTIL CONDOR OIL INVESTMENTS PTY LTD CAN FULFIL ITS STATUTORY REQUIREMENTS. AS THE MAJORITY UNIT/SHAREHOLDER IN CONDOR OIL INVESTMENTS PTY LTD IS ALSO THE MAJORITY SHAREHOLDER IN TRIAL HARBOUR MINING COMPANY, IT IS ENVISAGED THERE WILL BE NO PROBLEMS.

Appendix ①

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Revised version 21-01-94 for *Geochimica et Cosmochimica Acta*

Hydrocarbon biomarkers, thermal maturity and depositional setting of tasmanite oil shales from Tasmania, Australia.

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Abstract- This study represents the first geological and organic geochemical investigation of samples of tasmanite oil shale representing different thermal maturities from three separate locations in Tasmania, Australia. The most abundant aliphatic hydrocarbon in the immature oil shale from Latrobe is a C_{19} tricyclic alkane, whereas in the more mature samples from Oonah and Douglas River low molecular weight *n*-alkanes dominate the extractable hydrocarbon distribution. The aromatic hydrocarbons are predominantly derivatives of tricyclic compounds, with 1,2,8-trimethylphenanthrene increasing in relative abundance with increasing maturity. Geological and geochemical evidence suggests that the sediments were deposited in a marine environment of high latitude with associated cold waters and seasonal sea-ice. It is proposed that the organism contributing the bulk of the kerogen, *Tasmanites*, occupied an environmental niche similar to that of modern sea-ice diatoms and that bloom conditions coupled with physical isolation from atmospheric CO_2 led to the distinctive "isotopically heavy" $\delta^{13}C$ values (-13.5 ‰ to -11.7 ‰) for the kerogen. $\delta^{13}C$-data from modern sea-ice diatoms (-7‰) supports this hypothesis. Isotopic analysis of *n*-alkanes in the bitumen (-13.5 ‰ to -31 ‰) suggest a multiple source from bacteria and algae. On the other hand, the *n*-alkanes generated from closed-system pyrolysis of the kerogen (-15 ‰) are mainly derived from the preserved *Tasmanites* biopolymer algaenan. The tricyclic compounds (mean -8 ‰) both in the bitumen and pyrolysate, have a common precursor. They are consistently enriched in ^{13}C compared with the kerogen and probably have a different source from the *n*-alkanes. The identification of a location where the maturity of the tasmanite oil shale approaches the "oil window" raises the possibility that it may be a viable petroleum source rock.

INTRODUCTION

The oil prospectivity of onshore Tasmania has long been problematical. Interest in the possibility of finding oil has been stimulated by repeated reports of bitumen strandings on western and southern beaches since the late 19th century (TWELVETREES, 1917). This interest has continued, despite the fact that these coastal bitumens are now thought to arise from Mesozoic or Cainozoic offshore sediments that are poorly represented onshore (VOLKMAN et al., 1992). There have been, however, numerous reports over the last century of oil-seeps onshore (BENDALL et al., 1991) suggesting the possibility that older onshore rocks may also be a source of petroleum. Central to much of this interest has been the organic-rich tasmanite oil shale (subsequently referred to simply as "tasmanite" or "oil shale") which occurs particularly in the north-west of the state (Fig. 1). JAMES et al. (1932) reported that the oil shale was retorted to liberate hydrocarbons as early as 1910, and this carried on until the 1930's, producing about 1.13 megalitres of shale oil.

The tasmanite occurs as a distinctive band low in the Quamby Mudstone. The stratigraphy of Late Palaeozoic sediments in Tasmania has been the centre of much research interest (see CLARKE and FARMER, 1976; CLARKE, 1989) due to the difficulty of applying the (warm water based) internationally accepted biostratigraphic divisions to the cold water environment of Tasmania at this time. Because of this difficulty, the more appropriate Rekunian Series has been proposed (CLARKE and BANKS, 1975; CLARKE and FARMER, 1976) with a sub-division, the Tamarian stage, within which is the Quamby Mudstone (Fig. 2). That part of the Quamby Mudstone containing the oil shale has consistently yielded stage 2 microfloras (TRUSWELL, 1978) and a Faunal Zone 1 macrofauna (Fig. 2; CLARKE and BANKS, 1975). The age has been given as either Early Permian (FOSTER and WATERHOUSE, 1988) or Late Carboniferous (CLARKE, 1992) [i.e. a little older or a little younger than 290 my BP, taken as the age of the beginning of the Permian by HARLAND et al. (1990)].

The only lithological distinction between the oil shale and surrounding mudstone is that the former contains abundant algal remains. These are dominated by the unicellular alga *Tasmanites punctatus* Newton (1875) whose biological affinities have been suggested to lie with the extant green alga *Pachysphaera pelagica* Ostenfeld (1899) (WALL, 1962). Initially, the tasmanite was thought to have been deposited in an extensive lake (MILLIGAN, 1852), but the discovery of marine fossils (GOULD, 1861) precluded this. Recent work has suggested a nearshore marine origin (BANKS, 1962; CALVER et al., 1984) with the oil shale representing a period of algal blooms (CALVER et al., 1984; CLARKE, 1989). This hypothesis is further supported by comparison of the known occurrence of tasmanite with the inferred palaeogeography of Tasmania during the early Tamarian (BANKS and CLARKE, 1987; Fig. 3).

There has been much discussion about the correct nomenclature for the abundant microfossils found in the tasmanite (see WALL, 1962). The term spore has been used (SIMONEIT and BURLINGAME, 1973) while studies of some modern prasinophycean genera (*Pachysphaera, Halosphaera and Pterosperma*) have shown that the asexual reproductive cycle consists of a phycoma (cyst) and a motile stage (PARKE and HARTOG-ADAMS, 1965; PARKE, 1966; PARKE et al., 1978). GUY-OHLSON (1988) identified various developmental stages of *Tasmanites* in the Jurassic of Sweden and concluded that the fossil cysts were phycomata. Recent studies (BOALCH and GUY-OHLSON, 1992; GUY-OHLSON and BOALCH, 1992) have indicated that the morphology of fossil *Tasmanites* are sufficiently close to some rarely found living specimens of *Pachysphaera* that the genus *Tasmanites* suffices for both. TAPPAN (1980) indicates that the term phycoma describes the non-motile stage specific to prasinophytes and therefore, to use this description would indicate an acceptance that *Tasmanites punctatus*, found in Tasmanian tasmanite, is the equivalent of a modern prasinophyte. To avoid any taxonomic inference, the abundant microfossils in these samples will be referred to as *Tasmanites* or simply fossils. Although known to range from the Cambrian (540 Ma) to present, *Tasmanites* and related forms occur in high concentrations only in the tasmanite deposits of Tasmania (Permian) and Alaska (Jurassic) with other less abundant occurrences in the Sahara and Brazil (AQUINO NETO et al., 1992).

The fossils were spheroidal, but become disc shaped with sediment compaction, ranging in size from <0.1 mm to >0.6 mm in diameter. The wall of the fossil is formed of two to three layers, with the outer layer rarely preserved. The middle layer forms the bulk of the wall, the inner layer being thin and fibrous (KANTSLER, 1980).

The algal origin for the tasmanite and its organic richness has led to a wide range of geochemical studies of the kerogen. Data have been presented on carboxylic acids (BURLINGAME et al., 1969; SIMONEIT and BURLINGAME, 1973), and more recently the hydrocarbon content (PHILP et al., 1982; AZEVEDO et al., 1990; SIMONEIT et al., 1990; AZEVEDO et al., 1992). These studies have identified novel aliphatic and aromatic compounds, but all have been based on samples from the one site at Latrobe (Fig. 1), where the oil shale is relatively immature. In this paper we report a comprehensive organic geochemical study of the tasmanite oil shale, including a comparison of immature and mature samples from different locations in Tasmania.

EXPERIMENTAL

Samples

Samples were collected from rock outcrops at Oonah, Latrobe in the Mersey Valley and from a core taken at Douglas River (Fig. 1; for stratigraphy see Fig. 2). The rock sample from Latrobe shared many of the characteristics of that from Oonah, except that it came from a continuous 1.8 m seam, 21.4 m above the basal conglomerate within the Spreyton beds (Fig. 2). A spore concentrate was obtained from a sample collected at Oonah by density separation of the fossils from the crushed rock using ferric chloride.

Extraction

Total solvent-extractable compounds were obtained by sonication of the crushed rock samples (*ca.* 50 g) with chloroform/methanol (2:1, 3 x 50 ml). The composition of a portion of the total extracts was determined either by gravimetry after fractionation or by Iatroscan thin-layer chromatography-flame ionisation detection, using hexane as the developing solvent (VOLKMAN et al., 1986). Saturated and aromatic hydrocarbons were isolated by applying 30 mg of extract to a glass column containing 3 g of silicic acid (100-200 mesh) capped with 1 g of activated alumina (BDH). Aliphatic hydrocarbons were eluted with hexane (20 ml) and a second fraction containing aromatic hydrocarbons was obtained by eluting with hexane:toluene (1:1; 20 ml). Resins and ashphaltenes were eluted with chloroform (20 ml) and methanol (10 ml).

Analyses

Hydrocarbon fractions were analysed by capillary gas chromatography on a 50 m *non-polar methyl silicone fused silica capillary column* (HP-1, 0.32 mm i.d., 0.25 μm film) with on-column injection and hydrogen as the carrier gas. The temperature program was 45 °C for 1 minute, followed by a ramp to 120 °C at 30 °C min^{-1} then a ramp to 310 °C at 4 °C min^{-1}. The oven was then maintained isothermally for 15 min.

Biomarker information was obtained by gas chromatography-quadrupole mass spectrometry (Hewlett Packard 5790 MSD with HP 5890 GC and 59970A computer workstation) in selected ion monitoring (SIM) mode. Typical conditions were: electron multiplier 2200 V, transfer line 310 °C, electron impact energy 70 eV. GC conditions were as above except that helium was used as carrier gas. Samples were also analysed using metastable reaction monitoring GC-MS using a VG 70E instrument fitted with an HP 5790 GC and controlled by a VG 11-250 data system. The GC was equipped with a HP

Ultra-1 capillary column (50 m x 0.2 mm i.d.) connected to a OCI-3 cooled on-column injector (SGE) with a retention gap of uncoated fused silica (0.5 m x 0.33 mm i.d.). The oven was programmed from 50 °C to 150 °C at 10 °C min^{-1} and then to 300 °C at 3 °C min^{-1} with a final hold time of 30 min. The carrier gas was hydrogen with a linear flow of 30 cm s^{-1}. The mass spectrometer was operated with a source temperature of 240 °C , ionisation energy of 70 eV and interface and re-entrant at 310 °C. In full scan mode the MS was operated from *m/z* 650 to *m/z* 50 at 1.8 s per decade and an inter-scan delay of 0.2 s. In MRM mode, the magnet current and ESA voltage were switched to sequentially sample 26 selected parent-daughter pairs. The sampling time was 40 ms per reaction with a 10 ms delay giving a total cycle time of 1.3 s.

Gas chromatography-isotope ratio mass spectrometry (GC-IRMS) was carried out as described by HAYES et al. (1990) using a Finnigan-MAT 252 isotope ratio mass spectrometer linked to a Varian 3400 GC via a cupric oxide combustion furnace operated at 900 °C. Isotopic calibration was made using an external primary CO_2 standard introduced via a sample bellows and change-over valve and checked using deuterium labelled *n*-alkanes as internal standards. The latter, in hexane, were co-injected with the sample onto a J&W DB-5 capillary column (30 m x 0.25 mm i.d.) using a Varian SPI injector. The oven was programmed from 50 - 300 °C at 6 °C min^{-1}.

Closed-system Pyrolysis

Kerogen was isolated from the tasmanite shale by standard acid digestion techniques, and pyrolysed in evacuated quartz tubes for 72 hours at 300 °C, 330 °C and 350 °C, in the presence of water. Only liquid products were isolated and these were treated in the same way as other extracts. Rock-Eval derived kinetic parameters on whole rock samples of Latrobe tasmanite (AGSO #1995) were determined by Daniel Jarvie, Humble Instruments, Humble, Texas.

RESULTS AND DISCUSSION

Geological Setting of the Tasmanite Oil Shale

The tasmanite at Oonah consists of two seams, separated by up to 6.7 metres of siltstone. The lower and upper seams contain two and three *Tasmanites*-rich beds respectively. These beds consist of a multiplicity of lenses, each up to about a millimetre thick and a few centimetres long, separated by silt layers. The beds generally show a gradually increasing concentration of algal remains upwards. The fossil content decreases rapidly at the top of each bed. The oil shale contains fossils in spherical or flattened forms, the latter being much more common. Spherical *Tasmanites* are observed in fossil-poor sediment, but are absent or rare in fossil-rich sediment (Table 1), and tend to be filled with framboidal pyrite with or without collophane. The flattened disks are probably produced by compaction of the spheroidal form. The fossils exist as thin- and thick-walled specimens, the latter having two distinct walls (Fig. 4). The samples from Oonah contain relatively high levels of clay and silt (quartz) grade sediments. The fossil-rich sediments also contain a greater abundance of elongate, horizontal, silica-filled burrows (Table 1).

In the sample from Latrobe, silica-filled burrows are less prevalent and smaller than in the sediments from Oonah. The oil shale at this site exhibits large scale lensing as well as the small scale lensing noted above. This suggests a fluctuating environment, and the oil shale maintains a constant thickness possibly indicating an almost flat sea floor.

Within the core taken from Douglas River, two beds of oil shale can be recognised between 320 and 321.5 m (CALVER et al., 1984). The lower bed exhibits a fossil morphology very similar to that from Latrobe. The upper bed has a thin (20 cm thick) basal conglomerate which fines upwards into the oil shale. Similar small scale structures to those in the sample from Latrobe can be observed and the top of the shale is characterised by flame structures. The oil shale is overlain by a thin fining upwards sequence (*ca.* 50 cm thick) commencing with conglomerate. Dispersed *Tasmanites* are observed in the silt at the top of this sequence.

Bulk Parameters

Bulk parameters are given in Table 2. The samples from Oonah represent a span from the upper tasmanite seam to below the lower seam.

Total organic carbon (TOC) concentrations are consistently greater in the immature sample from Latrobe and the more mature Douglas River sample than in that of intermediate thermal maturity from Oonah (Table 2). There appears to be no direct correlation between organic carbon content and sulphur concentration in the Oonah sediments, except possibly in the upper seam (Fig. 5). The majority of sulphur is framboidal (Table 1) with the greatest concentration coinciding with the fossil-rich sediments. In the sample from Latrobe, pyrite is present in lower concentrations than at Oonah and appears to be proportional to the TOC content (Fig. 5). Despite having the lowest maturity, the relative amount of extractable organic matter in the Latrobe material is *ca.* three times that of the other samples. This probably reflects a generally higher fossil concentration in these samples, with some being almost 74 % *Tasmanites*.

Total extractable organic matter contained from 56% hydrocarbons in the Latrobe sample to 95% hydrocarbons in the lower shale seam at Oonah; the remainder being attributed to polar material (Table 2).

The high Hydrogen Index (HI) of the Latrobe, Oonah upper seam and Douglas River samples (Table 2) classify the kerogen as containing hydrogen-rich Type I organic matter (TISSOT and WELTE, 1984) wherein over 70 % of the organic matter is convertible to hydrocarbons. The slightly reduced HI value from the Oonah lower seam may be a result of more oxidation/reworking consistent with the elevated Oxygen Index (OI) value.

Hydrocarbon Distributions and Source Characteristics

The GC-FID traces (Fig. 6) of the saturated hydrocarbons from the tasmanite extracts show *n*-alkane distributions dominated by lower molecular weight components with distributions maximising between *n*-C_{11} and *n*-C_{13}, with little odd or even predominance (Table 3). Samples also contained significant amounts of the acyclic isoprenoids pristane and phytane, though in different relative proportions (Table 3). The siltstone sample has a Pr/Ph ratio higher than the oil shales (Table 3), consistent with deposition under more oxic conditions.

For the purposes of this study, detailed analyses were only conducted on three of the samples: a thermally immature rock sample from Latrobe, the *Tasmanites* fossil concentrate from Oonah and the core sample from Douglas River. All the samples contain steranes and diasteranes as shown by the *m/z* 217 mass chromatograms (Fig. 7), which is in contrast to their presence as only "trace components" in a sample from Latrobe (Fig. 1) analysed by SIMONEIT et al. (1990).

The relative proportions of C_{27}, C_{28} and C_{29} steranes show some variation between the samples (Table 3) with C_{29} dominant in the Latrobe sample, C_{27} in Oonah and no preference at Douglas River. Although this may reflect subtle differences in source inputs, maturity will also have an influence. C_{30} 24-*n*-propylcholestanes which are generally accepted to be indicative of a marine source (MOLDOWAN et al., 1990), could not be easily detected in the *m/z* 217 mass chromatogram, but were readily identified (though less so in the Douglas River sample) using MRM together with 2α-methyl and 3β-methyl sterane isomers (Figs. 8-10). The samples also contain relatively high proportions of diasteranes (Fig. 7; Table 3) which were not reported in samples previously analysed (SIMONEIT et al., 1990).

The GC-FID chromatograms and extended *m/z* 191 mass chromatograms for each sample show a high abundance of tricyclic compounds (Figs. 6 & 11) and these extend to at least C_{35}. In the *m/z* 191 chromatograms hopanes occur in trace amounts while C_{21}, C_{23} and C_{24} tricyclic compounds show the greatest intensity. However, the FID chromatogram reveals the predominant tricyclic terpane is a C_{19} compound. In the C_{19} pseudo homologue, the abundance of the *m/z* 191 ion is minor compared with the base peak at m/z 123 (AQUINO NETO et al., 1982). In the MRM reactions used to detect hopanes (Figs. 8-10; e.g. 412 → 191 for the C_{30} hopane), tricyclic terpanes appear as non-quantitative artefacts as a consequence of their high relative abundance and the limitations of the linked scan technique used for the analysis. Only the C_{30} tricyclic is specifically detected using the 416 → 191 reaction. Measurement of the C_{27} Ts/Tm hopane ratios was not possible due to interference from an unknown compound co-eluting with Ts.

Examination of the aromatic fraction of samples from Oonah and Douglas River show they are dominated by a single compound (Fig. 12) which was identified by GC-MS as a C_3-phenanthrene. This was positively identified by co-injection with an authentic standard as 1,2,8-trimethylphenanthrene. This compound is seen as one end member of an identifiable aromatisation sequence as indicated by the presence of partially aromatized intermediates in the less mature samples from Latrobe (Fig. 12; Scheme 1).

Maturity

The samples from Latrobe and the *Tasmanites* concentrate from Oonah exhibit a predominance of the thermodynamically less stable $5\alpha,14\alpha,17\alpha(H)$ (*c.f.* $5\alpha,14\beta,17\beta(H)$) sterane isomers (Table 3) indicating that they are thermally immature. This is further emphasised by the greater proportion of the $5\alpha,14\alpha,17\alpha(H)$ 20R epimer compared with the 20S epimer and the presence of small amounts of $5\beta(H)$-steranes (as determined by metastable reaction monitoring, MRM). A value of 0.54 for the 20 S/S+R sterane ratio (Table 3) suggests the Douglas River sample is within the oil window (PETERS and MOLDOWAN, 1993). An αββ/ααα ratio of 0.5 is consistent with this, the onset of the oil window occurring at about 0.25 (PETERS and MOLDOWAN, 1993).

Maturity estimates based on phenanthrenes (*viz.* the methylphenanthrene index, MPI; Table 3) showed little discrimination. The uniformity in the MPI has been observed previously for low maturity and hydrogen-rich marine organic matter (RADKE et al., 1986; BOREHAM et al., 1988). The presence of aromatic compounds which appear to be derived from the tricyclic precursors in such immature samples (both this study, AZEVEDO et al., 1992 and REVILL et al., 1993) suggests that aromatisation has occurred early in the maturation process. This possibly reflects the unusual nature of the organic matter or microbial influences on the aromatisation processes (TRENDEL, 1985; LOHMANN, 1988; TRENDEL et al., 1989; WOLFF et al., 1989).

There is little evidence to suggest which tricyclic compound is being preferentially converted to the aromatic compounds. The only noticeable correlation being a relative decrease in the complexity of the *m/z* 191 mass chromatogram in the C_{20} region in the Douglas River sample compared with the Oonah *Tasmanites* concentrate (Fig. 11), which is assumed to be a maturity driven decrease in the three stereoisomers relative to the 13β(H),14α(H) compound (CHICARELLI et al., 1988).

The plot of T_{max} *vs.* HI (Fig. 13) shows very similar T_{max} (443 - 446 °C) values for the Latrobe, Oonah fossil concentrate and Douglas River samples. However, the siltstone from above and below the oil shale has a similar maturity but shows a much lower T_{max} (436 °C), equivalent to a vitrinite reflectance of 0.5 % for Type III kerogen (Fig. 13). This emphasises the limited use of the T_{max} parameter in assessing the thermal maturity of Type I kerogens (TISSOT et al., 1987).

The Production Index (PI) for the most thermally mature sample (Douglas River) is only 0.04 (4 %; Table 2), which indicates an immature kerogen (BORDENAVE et al., 1993). This suggests that the biomarker data (steranes) are over-estimating the thermal maturity of the samples, which is consistent with recent results. MARZI and RULLKÖTTER (1992) calculated an activation energy for sterane isomerization at C_{20} of 169 kJ / mol, while kinetic data derived for the tasmanite indicates a typical Type I distribution (TISSOT et al., 1987). There is a very narrow distribution of activation energies for kerogen transformation (Fig. 14) which, in combination with the frequency factor of 8.9 x 10^{13}, indicates a relatively labile kerogen once generation commences. When these data are used to model maturity it becomes clear that the 20 S/ 20 R isomerisation is complete before the onset of significant hydrocarbon generation (Fig. 15). In contrast, the kinetic data for sterane isomerisation calculated by MACKENZIE and MCKENZIE (1983) predicts over 50 % kerogen conversion for the Douglas River sample (Fig. 15), clearly inconsistent with its high HI value.

Calculation of the Transformation Ratio (TR) according to hydrogen index (HI) values:

$$TR = \frac{HI_o - HI_z}{HI_o}$$

Where HI_0 and HI_Z are the initial HI value and the HI at a depth z respectively. HIo is taken as the value for Latrobe (Table 2).

shows the Douglas River sample to have a TR value of 0.1, considered to define the onset of petroleum generation. Thus, from the kinetic data curve (Fig. 14) it is clear that this sample has only just started hydrocarbon production, but significantly, an increase of only 10-15 °C to exceed the activation energy, would see a rapid increase in the amount of petroleum production. The production curve (Fig. 15) shows that some hydrocarbons have been produced quite early in the maturation sequence, and this is probably due to the presence of weaker bonds within the kerogen. These are represented by the lower activation energies (205 and 209 kJ /mol; Fig. 14) and probably reflect the sulphur content of the kerogen. Clearly, the depth of the oil shale at Douglas River (320 m) is insufficient to produce this level of thermal maturity, even given a high geothermal gradient for this area of around 30 °C / km (GREEN, 1989). This could reflect significant erosion of Tertiary material, or be due to past and localised heating of the organic matter. Too little is currently known about the geology of this region of Tasmania to assess which is the more likely of these two alternatives.

The high TOC and HI values confirm that the tasmanite has the potential to generate large amounts of hydrocarbons but importantly, in the east of Tasmania, as shown by the data from Douglas River, its thermal maturity is near the oil window. This result contradicts previous assumptions that the oil shale in Tasmania is too immature to represent a possible petroleum source, although the present day areal extent of mature strata is unknown.

Inferred Environment of Deposition

BANKS (1962), KANSTLER (1980) and CALVER et al. (1984) suggested that *Tasmanites* represents the "cysts" of a planktonic organism living in a restricted environment, generally littoral and associated with reduced salinity due to a high fresh water input. It has been suggested that much of present-day Tasmania was covered during the Late Carboniferous by an ice sheet flowing from the west (BANKS AND CLARKE, 1987). At that time Tasmania was positioned in high southern latitudes (ca. 75° - 80° S; SMITH et al., 1981). As the glaciers retreated, black muds were deposited on the sea floor in front of the ice, and it was in these muds that beds of tasmanite were formed. The occasional presence of fossil brachiopods and starfish in the tasmanite shale indicates a marine setting. Deposition in quiescent shallow to very shallow water is indicated by fine-scale cross lamination, scouring and lensing-out over very short distances of both the siltstone and *Tasmanites*-rich layers in oil shale from Oonah and by the close association with lenticular sand and well-sorted granule bodies in the Douglas River core. It is suggested that deposition occurred in water depths of 100 m or less (Fig. 3); a nearshore deposition is further suggested by the presence of desmocollinite at Oonah and collinite at Latrobe. The overall fine grain size of the oil shale-bearing sequence shows that very low current strengths existed at the site of deposition. Lonestones, some of which are demonstrably dropstones (Fig. 4b), may have been transported to the site by shore ice as their shapes are characteristic of fluvial and beach environments with little evidence for transport by glacial ice (DOMACK et al., 1993).

Estimates of sea surface temperature for early Permian Tasmania of -1.8 °C (RAO and GREEN, 1982), are close to the present average near the Antarctic ice shelf of -1.9 °C. DOMACK et al. (1993) propose that the tasmanite beds record a period of enhanced primary productivity coupled with polar to sub-polar glacial marine conditions characterised by very cold waters, seasonal sea ice and shore-ice rafting. Cold water deposition is consistent with the low diversity of the invertebrate fauna and strongly indicated by the presence of glendonites, pseudomorphs after ikaite (calcium carbonate hexahydrate; $CaCO_3.6H_2O$). This mineral is suggested to be an authigenic precipitate, forming at low temperatures from interstitial waters of organic-rich sediments, undergoing microbial degradation and accumulated rapidly in cold bottom waters (SUESS et al., 1982; SHEARMAN and SMITH, 1985; JANSEN et al., 1987).

It is notable that the sediments where *Tasmanites* is abundant, in the Late Ordovician-Early Silurian of the Sahara, the Devonian of Brazil, the Late Carboniferous-Early Permian tasmanite of Tasmania and the *Tasmanites*-rich deposits of the Jurassic/Cretaceous of the Brooks Range, Alaska, all have palaeolatitudes, inferred from palaeomagnetic work, of about 75° (SMITH et al., 1981). Sediments where *Tasmanites* is of low abundance seem to have had a wider latitudinal range. For example its occurrence at about 10°S in the Devonian of Indiana and Ohio (SMITH et al., 1981), indicates that it was a wide ranging organism comparable to some diatoms and prasinophytes in contemporary oceans.

Pyrite occurs within some fossils, but also separately in the fine siltstone and between fossils. The pyrite is predominantly framboidal and seems to have been an early diagenetic deposit, especially in associated conglomerates. This indicates a reducing environment soon after deposition, which is also supported by the presence of glendonites. Identifiable burrows in the sediments suggest only mild bioturbation and that bottom waters were depleted in oxygen at the time of deposition which, combined with low temperatures, reduced the rate of oxidation of the organic matter such that little was oxidised prior to burial. Low pristane/phytane ratios are often associated with low-oxygen environments such as the tasmanite (Table 3; DIDYK et al., 1978), although other factors can be important (TEN HAVEN et al., 1987). In contrast, the siltstone above and below the tasmanite shale which represents deposition in an oxic environment exhibits a relatively high pristane/phytane ratio of 3.1. Our data is consistent with earlier models of tasmanite deposition, suggesting that the sum of the physical properties indicates deposition in a dysaerobic environment with a dissolved oxygen content less than 0.5 ml L^{-1} at the sediment-water interface (ARTHUR et al., 1984).

SIMONEIT et al. (1992; 1993) reported high ^{13}C enrichment for the tricyclic compounds ($\delta^{13}C$ values of -9.9‰ to -12.2‰) extracted from an immature sample from Latrobe (Fig. 1) which was attributed to bloom conditions prevailing at the time of deposition. Phytoplankton from cold, high latitude waters are typically depleted in ^{13}C due to the elevated pCO_2 caused by increased CO_2 solubility at these temperatures (reviewed by SACKETT, 1991). Low atmospheric pCO_2 associated with global glaciation (RAU et al., 1991a) in the Early Permian, possibly combined with additional pCO_2 drawdown during algal blooms provides a possible explanation for the ^{13}C enrichments of tasmanite kerogen reported here and by SIMONEIT et al. (1993). However RAU et al. (1991b) showed that particulate organic matter associated with sea ice could also be significantly enriched in ^{13}C ($\delta^{13}C$ -16‰ to -28‰) relative to the seawater. Within the sea-ice the physical isolation from re-equilibration with the atmosphere may reduce CO_2 availability and therefore significantly reduce isotopic fractionation. SIMONEIT et al. (1993) reported a tasmanite kerogen with a $\delta^{13}C$ value of -16.6‰ and our samples have $\delta^{13}C$ values of -13‰ to -11‰ (Fig. 16). Thus, in view of the depositional setting implied by geological evidence we propose that *Tasmanites* in this instance may have occupied an environment very similar to that of present day sea-ice algae. Thus, by analogy with present day sea-ice diatom communities, the *Tasmanites* bloomed within the ice as the light intensity increased during the spring. As the ice melted, algae from the bloom were released into the water column and subsequently sedimented. The fine scale laminations and rarity of bioturbation are consistent with a quiescent water column, which may be assisted by persistent ice cover. To test this hypothesis we measured the $\delta^{13}C$ for sea ice diatoms collected from ice cores taken in Antarctica, during November 1991. These gave a $\delta^{13}C$ value of -7‰ (Fig. 16) which supports this interpretation. Further studies of sea ice algae from several Antarctic locations have confirmed their ^{13}C enrichment compared to algae isolated from the associated water column (R. E. SUMMONS and P. D. NICHOLS unpublished data). The taxonomic assignment of *Tasmanites* with the Prasinophyceae (Chlorophyta) (WALL, 1962; PARKE, 1966) and the observations of TAPPAN (1980), who suggested that the fossil prasinophytes are a "disaster species", somehow surviving the widespread extinctions of the middle Palaeozoic and, perhaps most importantly, thriving in the absence of other phytoplankton, are all consistent with our model.

Origins of Biomarkers in the Tasmanite Oil Shale

Recently COLLISTER *et al.* (1992) reported isotopic values for tricyclic compounds in the Green River oil shale which ranged from -33.7‰ to -27.3‰. This range corresponds to the values generally associated with photoautotrophs, but there was no correlation with the values for β–carotane or steranes in the same samples, indicating different source organisms. The difference between the isotopic values of COLLISTER et al. (1992) and those reported here and by SIMONEIT et al. (1993) may be due to the source organism occupying a different niche in the very different environments of deposition.

The high proportion of preserved organic remains in the tasmanite oil shale, and the dominance of tricyclic compounds in the hydrocarbon fractions, has often led to *Tasmanites* to be proposed as the likely source for these compounds (e.g. VOLKMAN et al., 1989; SIMONEIT et al., 1992; 1993). However, tricyclic compounds have been identified in a wide range of sediments and petroleum from a range of geological ages, and do not appear to be limited to areas of high *Tasmanites* content (see AQUINO NETO et al., 1983), so other sources must be examined. A consideration of $\delta^{13}C$ values of tricyclic compounds in the extracts and pyrolysates of the tasmanite oil shale provides evidence for a source distinct from the accompanying algaenan.

GC-IRMS analysis of tricyclics in previous studies (SIMONEIT et al., 1993) and the present study yielded $\delta^{13}C$ values of -9.9‰ to -12.2‰ and -6.4‰ to -11.3‰ respectively, which shows that these compounds are enriched in ^{13}C compared with the corresponding kerogen (Fig. 16). The light and variable isotopic composition for the *n*-alkanes ($\delta^{13}C$ values -18 ‰ to -30 ‰) suggests multiple sources. There is a general trend for ^{13}C depletion in higher *n*-alkane homologues, suggesting a possible contribution from allochthonous bacterial or plant waxes. For the lower *n*-alkane homologues, algal and cyanobacterial sources may become increasingly important.

Closed-system pyrolysis of tasmanite kerogen for 72 hours at increasingly higher temperatures showed a number of interesting trends (Table 4). Recovery of bitumen maximised at 68 % at 330 °C and decreased to 59 % at 350 °C, probably as a result of the generation of a larger proportion of gas resulting from cracking of liquid hydrocarbons. The composition of the bitumen also changed markedly. At 350 °C almost 96 % of the bitumen could be recovered from the chromatographic column, as saturates, aromatics and weakly polar materials. At 300 °C and 330 °C the recoveries from column chromatography were only 52 % and 57 % respectively, indicating that the pyrolysate comprised a major proportion of asphaltic or strongly polar material which bound irreversibly to the silica gel. The proportions of saturates, aromatics and weakly polar fractions in the material recovered from column chromatography did not change significantly as the pyrolysis temperature increased.

A comparison of GC traces for the C_{10+} saturated hydrocarbons (Fig. 17) shows a low abundance of *n*-alkanes compared to tricyclanes in the extract and the 300 °C pyrolysate. At the higher temperatures, *n*-alkanes dominate the GC-FID chromatogram, consistent with flash pyrolysis-GC results which revealed the aliphatic nature of the tasmanite kerogen (C. J. BOREHAM, unpublished data). There is also a progression in *n*-alkane generation leading to reduced waxy *n*-alkane contents and lower molecular weight predominance as the temperature increases to 350 °C. In the 300 °C pyrolysate, the *n*-alkane envelope maximises at C_{18} compared with C_{14} in the 350 °C pyrolysate. Evidence for this evolution is also shown by $\delta^{13}C$ analysis of the alkanes (Fig. 18) and comparison with those in the extract. The *n*-alkanes produced at 300 °C exhibit an isotopic composition closest to those of the extract with a progression to "heavier" compounds with an increase in pyrolysis temperature. Note that at 350 °C the $\delta^{13}C$ values of C_{15}-C_{24} *n*-alkanes are in the range -12‰ to -15‰, compared with the kerogen at -12‰. The C_{13} and C_{14} *n*-alkanes are now prominent (Fig. 16) and are slightly "heavier" than the starting kerogen at -10‰ to -11.5‰, although this could be due, in part, to isotopic fractionation on evaporative loss of some of the volatile *n*-alkanes.

The observations from the pyrolysis experiments are consistent with the concept of generation of an asphaltene- and polar-rich material during the initial stages of kerogen conversion (EVANS and FELBECK, 1983), and subsequent cracking of this to lower molecular weight components, including gaseous products. The main information conveyed by the isotope data is, however, that the $\delta^{13}C$ values of the *n*-alkanes produced by kerogen pyrolysis are significantly different from those in the extract of immature tasmanite. Pyrolytically generated *n*-alkanes and *n*-alkylcyclohexanes (data not shown) are isotopically similar to the kerogen consistent with earlier observations (BURWOOD et al., 1988) of a close correlation between ^{13}C contents of sapropellic kerogens and their pyrolysates. Based on experience with other algal-derived kerogens (e.g. GOTH et al., 1988; TEGELAAR et al., 1989; DERENNE et al., 1992; BOREHAM et al., 1994), these compounds are probably derived from an *n*-alkyl based biopolymer, algaenan, which forms part of the structure of the tasmanite fossils. Indeed, the $\delta^{13}C$ values are constant for the C_{17} - C_{27} *n*-alkanes from the 330 °C pyrolysate. Here, yields are high, secondary cracking is minimal and the isotopic value is considered to represent that of the *Tasmanites* algaenan. This is also consistent with the reported aliphatic nature of the preserved organic matter (KJELLSTRÖM, 1968).

Saturated tricyclic alkanes did not appear to be generated during the 330 °C and 350 °C pyrolyses where the *n*-alkanes were mostly produced. Their abundance relative to the *n*-alkanes decreased as the temperature increased. Caution should be exercised however. Tricyclic hydrocarbons may have been converted to aromatics at higher pyrolysis temperatures. Furthermore, the composition of the aromatic fractions generated in the pyrolysis experiments became much simpler with increasing temperature and at 350 °C was dominated by 1,7-dimethylphenanthrene and 1,2,8-trimethylphenanthrene with $\delta^{13}C$ values of -7.9 ‰ and -5.7 ‰ respectively, which are within the range for tricyclic compounds in the tasmanite extracts of different maturities (Fig. 16). The isotopic similarity in the tricyclic hydrocarbons from pyrolysis and tasmanite extracts (Scheme 1 and Fig. 18) suggest that they are almost certainly derived from the same precursors. A proposed genetic relationship between the tricyclic hydrocarbons is shown in Scheme 1. It is uncertain at present whether this process is mediated by bacteria or by heating in the natural environment (LOHMANN, 1988; FREEMAN, 1991; FREEMAN et al., 1994). Certainly, the latter process is indicated by the bias towards the fully aromatised tricyclics in both the pyrolysates and the higher maturity Oonah and Douglas River extracts.

However, the occurrence of the monoaromatic des-A-triterpane (-8.5 ‰; Fig. 12; FREEMAN et al., 1994) suggests a contribution from the former process (LOHMANN, 1988).

The isotopic dissimilarity of the tricyclic hydrocarbons (mean -8 ‰) to the kerogen and kerogen-derived *n*-alkanes suggests a source distinct from the *Tasmanites* themselves.

Interestingly, the difference in kerogen $\delta^{13}C$ data in this study with that of SIMONEIT et al. (1993) is matched by differences of a similar magnitude in the tricyclic compounds, aromatic derivatives and *n*-alkanes in the extracts. This, in conjunction with the previously noted differences in sterane and hopane observations, suggests that there were fluctuations in the source and depositional environment of organic matter within the oil shale seam which affected both biomarker distributions and their ^{13}C isotopic values.

CONCLUSIONS

This study represents the first organic geochemical comparison of thermally mature and immature tasmanite oil shale samples in conjunction with a detailed geological evaluation of the sedimentary setting.

1). This study has shown, for the first time, that at least some deposits of the tasmanite shale in Tasmania are near the "oil window".

2). Geological, isotopic and biomarker analysis indicates that *Tasmanites* thrived in an environment of ice cover and bloomed in conditions analogous to those experienced by present-day sea-ice diatoms. The algal cells were subsequently deposited in sediments overlain with oxygen-depleted waters, induced by restricted water movement.

3). Closed-system pyrolysis suggests that there is little correlation between the temperature profiles for production of *n*-alkanes and the tricyclic compounds from the kerogen precursors. The *n*-alkanes are mainly derived from thermal cracking of algal aliphatic biopolymer whereas the tricyclic alkanes and aromatic hydrocarbons are generated earlier, possibly from a different source.

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Table 1. Examples of oil shale characteristics at Oonah.

	Lower bed- lower seam	Lower bed - Upper seam	Middle bed - Upper seam	Upper bed - Lower seam
Thickness of oil shale (m)	0.28-0.42	0.3-0.7	0.38-0.59	0.24-0.28
Thin walled : thick walled fossils	16:1	6.5:1	10.5:1	5.6:1
% Matrix	48.9	71.4	48.8	74.8
% Fossils	36.5	10.1	32.2	5.4
% Spherical fossils	<0.2	0.4	0.2	0.6
% Pyrite framboids	3.5	2.0	4.3	3.7
% Non-framboidal pyrite	1.3	<0.2	<0.2	<0.2
% Vitrinite	0.5	0.2	0.4	n/d
% Elongate burrows	1.2	0.6	1.4	0.6
% Other*	7.9	15.5	12.5	15.3

* Predominantly clay and silt
n/d = not detected
Percentages are from point counts using approximately 500 data points

Table 2. Bulk parameters for tasmanite samples

Sample	Sample No.†	TOC (% whole sample)	EOM (mg/g TOC)	Iatroscan TLC-FID: Hydrocarbons (%, (mg/g TOC))	Iatroscan TLC-FID: Polars (%)	Rock-Eval: T_{max} (°C)	Rock-Eval: S_1 (kg/Tonne)	Rock-Eval: S_2 (kg/Tonne)	Rock-Eval: S_3 (kg/Tonne)	Rock-Eval: PI	Rock-Eval: HI	Rock-Eval: OI
Latrobe	1	31.3	52	56* (29)	44	444	12.5	304.2	5.6	0.039	972	18
Oonah												
Upper Seam												
Total	2	6.9	66	94 (62)	6	443	3.6	65.2	0.3	0.052	937	4
fossil Concentrate	3	63.0	23	85 (19)	15	446	30.8	590.8	2.3	0.050	937	3
Siltstone above seam	9	1.01	n.m.	n.m.	n.m.	437	0.04	0.89	0.73	0.04	88	72
Siltstone between seams	7	0.78	n.m.	n.m.	n.m.	440	0.07	1.30	0.34	0.05	166	43
Lower Seam												
Total	6	8.1	32	95 (30)	5	440	1.4	54.4	2.2	0.025	675	27
fossil Concentrate	4	61.3	n.m.	n.m.	n.m.	444	22.82	534.94	3.23	0.04	872	5
Siltstone below seam	8	1.1	35	73 (25)	27	436	0.1	1.8	0.6	0.052	163	51
Douglas River	5	17	34	90 (31)	10	446	6.3	147.5	0.2	0.041	868	1

† Sample number refers to Fig. 13
n.m. = not measured
* determined by gravimetry
PI = Production Index = S_1 / S_1 + S_2

Table 3: Molecular data for tasmanite samples

Sample	1 Pr/Ph	2 Pr/C_{17}	3 CPI	Parameter 4* steranes $C_{27:28:29}$	5* Diasteranes	6* 20S/S+R	7* αββ/αββ + ααα	8 MPI
.atrobe	0.45	0.62	n.d.	1.4:1:2.6	0.12	0.11	n.d.†	n.d.‡
Donah								
Upper Seam								
Total	1.6	0.69	0.92	n.m.	n.m.	0.30	0.15	n.m.
fossil concentrate	1.5	0.60	1.03	2.2:1:1.9	0.35	0.35	0.15	0.46
Lower Seam								
Total	1.4	0.48	0.83	n.m.	n.m.	0.31	n.m.	n.m.
Siltstone	3.1	0.91	1.40	n.m.	n.m.	n.m.	n.m.	n.m.
Douglas River	0.7	0.45	0.98	2:1:2	0.64	0.54	0.5	0.36

calculated from MRM data, † αββ probably absent, isomer is 20R 5β,14α,17α(H), .‡ MPI not applicable at this maturity
.d. = Not detected; n.m. = Not measured
arameters:
. Pristane / Phytane
2. Pristane / n-C_{17}
. Carbon Preference Index $= \dfrac{(\%C_{25}-C_{33}\text{ odd})+(\%C_{23}-C_{31}\text{ odd})}{2(\%C_{24}-C_{32}\text{ even})}$
4. 5α,14α,17α(H) 20R steranes
5. C_{29} Diasteranes (βα 20S + 20R) / (ααα + αββ 20S & 20R)
6. C_{29} ααα sterane 20S / 20S + 20R
7. C_{29} αββ 20R steranes / C_{29} 20R (ααα +αββ) steranes
8. Methyl Phenanthrene Index $= \dfrac{1.5(2\text{-}MP+3\text{-}MP)}{P+1\text{-}MP+9\text{-}MP}$

Table 4. Comparison of whole rock extract and kerogen pyrolysate of tasmanite from Latrobe, Tasmania

72 hr Pyrolysis Temp. (°C)	EOM (mg/g TOC)#	C_{12} + Saturates* (%)	Aromatics* (%)	Polars* (%)	Asphaltenes‡ (%)
unheated	51.4	19.0	30.5	38.8	11.7
300	190.8	7.0	13.3	31.3	48.4
330	1019.2	8.5	13.9	39.3	38.3
350	879.1	14.9	42.1	39.7	3.3

TOC (kerogen) = 67.1 %
* Based on pre-chromatography weight
‡ Taken as that fraction not eluting from the chromatographic column

FIGURE LEGENDS

Fig. 1. Sample locations

Fig. 2. Correlation chart for the lower (Carboniferous and Permian) sections of the Parmeener Supergroup for Latrobe and Douglas River (adapted from BANKS and CLARKE, 1987). Sst = Sandstone, CMs = Coal Measure Formation

Fig. 3. Suggested paleogeography of Tasmania during the Early Tamarian stage. Dashed lines = isopachs, numbers = thicknesses in metres, T = occurrence of tasmanite oil shale, ▨ = land areas, ▩ = areas of unknown geography. (Adapted from BANKS and CLARKE, 1987).

Fig. 4. (a) Fossil *Tasmanites* filled with pyrite from Oonah, (diameter = ca. 0.5 mm) and (b) Dropstone in tasmanite shale from Oonah. Note how the stone breaks the bedding of the shale, (magnification = x 10).

Fig. 5. Relationship between TOC and sulphur content in tasmanite samples. The upper graph shows the relationship with height above the Wynard tillite in a sample from Oonah. T indicates the oil shale seams. The lower graph shows the general relationship in samples taken from Latrobe.

Fig. 6. Gas chromatograms of the aliphatic fractions of extracts from samples taken from Latrobe, Oonah and Douglas River and an example tricyclic (cheilanthane) structure. Numbers refer to carbon number; Pr = pristane; Ph = phytane; T = tricyclic alkane. Note that the Latrobe fraction was analysed using a different temperature program.

Fig. 7. Extended *m/z* 217 mass chromatograms for samples from Oonah and Douglas River. Numbers refer to carbon number; D = diasteranes; 20S and 20R refer to stereochemistry at carbon 20. Those denoted $\alpha\alpha\alpha$ 20R have biological stereochemistry, i.e. $5\alpha,14\alpha,17\alpha$(H)-20R with the other signals arising from "geological" isomers.

Fig. 8. Distribution of sterane and terpane biomarkers in the saturated hydrocarbon fraction isolated from the Latrobe sample. The data were acquired by gas chromatography-mass spectrometry using metastable reaction monitoring (MRM). Each trace is identified with the carbon number, the reaction as determined by the masses of the parent and daughter ions, and a normalised relative abundance. The last peak to elute in each sterane trace (i.e. those denoted ααα-20R) have 5α,14α,17α(H) - 20R stereochemistry with the other signals arising from "geological" isomers. The desmethyl steranes are 24-*n*-propylcholestane (C_{30}), 24-ethylcholestane (C_{29}), 24-methylcholestane (C_{28}) and cholestane (C_{27}). The C_{30} methylsteranes are 24-ethylcholestanes with an additional methyl group in ring-A i.e. 2α-methyl and 3β-methyl which are denoted 2α(Me), 3β(Me) respectively. Hopanes are denoted H, tricyclics T and unknown compounds U. Tricyclic terpenoids appear in each hopane reaction as artefacts of the MRM analysis using the linked scan technique. For example, T_{30} is specifically detected in the 416→191 reaction. It also appears as an artefact, along with T_{31} in the 412 →191 reaction.

Fig. 9. Distribution of sterane and terpane biomarkers in the saturated hydrocarbon fraction isolated from the Oonah sample, from GC-MS analysis with MRM (see Fig. 8 legend for an explanation of symbols).

Fig. 10. Distribution of sterane and terpane biomarkers in the saturated hydrocarbon fraction isolated from the Douglas River sample, from GC-MS analysis with MRM (see Fig. 8 legend for an explanation of symbols).

Fig. 11. Extended m/z 191 mass chromatogram for extracts from Latrobe, Oonah and Douglas River. Numbers refer to carbon number; T = Tricyclics; H = Hopane. Symbols refer to isomerisation at carbons 13 and 14. For example, βα refers to 13β(H), 14α(H). Assignments are taken from CHICARELLI et al. (1988). T_{25} *structure is shown in Fig. 6.*

Fig. 12. Gas chromatograms of the aromatic fractions isolated from samples collected at Latrobe, Oonah and Douglas River. Peak assignments are indicated by structures. The peak assigned as des-A-gammacerane was identified by the major ions in it's mass spectrum M^+ 274 (36 %), 259 (100), 244 (8), 230 (15), 229 (25), 228 (11), 215 (16).

Fig. 13. HI/Tmax plot showing the relative positions of the samples. Note the difference in maturity shown by the algal kerogen and the associated siltstone. The standard 0.5% Vitrinite reflectance contour is shown. 1 = Latrobe, 2 = Oonah upper seam whole rock, 3 = Oonah *Tasmanites* concentrate, 4 = Oonah lower seam *Tasmanites* concentrate, 5 = Oonah lower seam whole rock, 6 = Douglas River whole shale, 7,8,9 = Siltstone samples from above and below the oil shale at Oonah.

Fig. 14. Plot showing the distribution of activation energies in the Latrobe tasmanite kerogen. FF = Frequency Factor.

Fig. 15. Simulated maturation of the Latrobe tasmanite kerogen, compared with sterane isomerisation at C_{20}. Sterane activation energies used are those of MACKENZIE and McKENZIE (1983) -•- and MARZI and RULLKÖTTER (1992) -♦-, at 8 °C per million years. Tasmanite maturation is shown at 8 °C (-□-) and 2 °C (-■-) per million years.

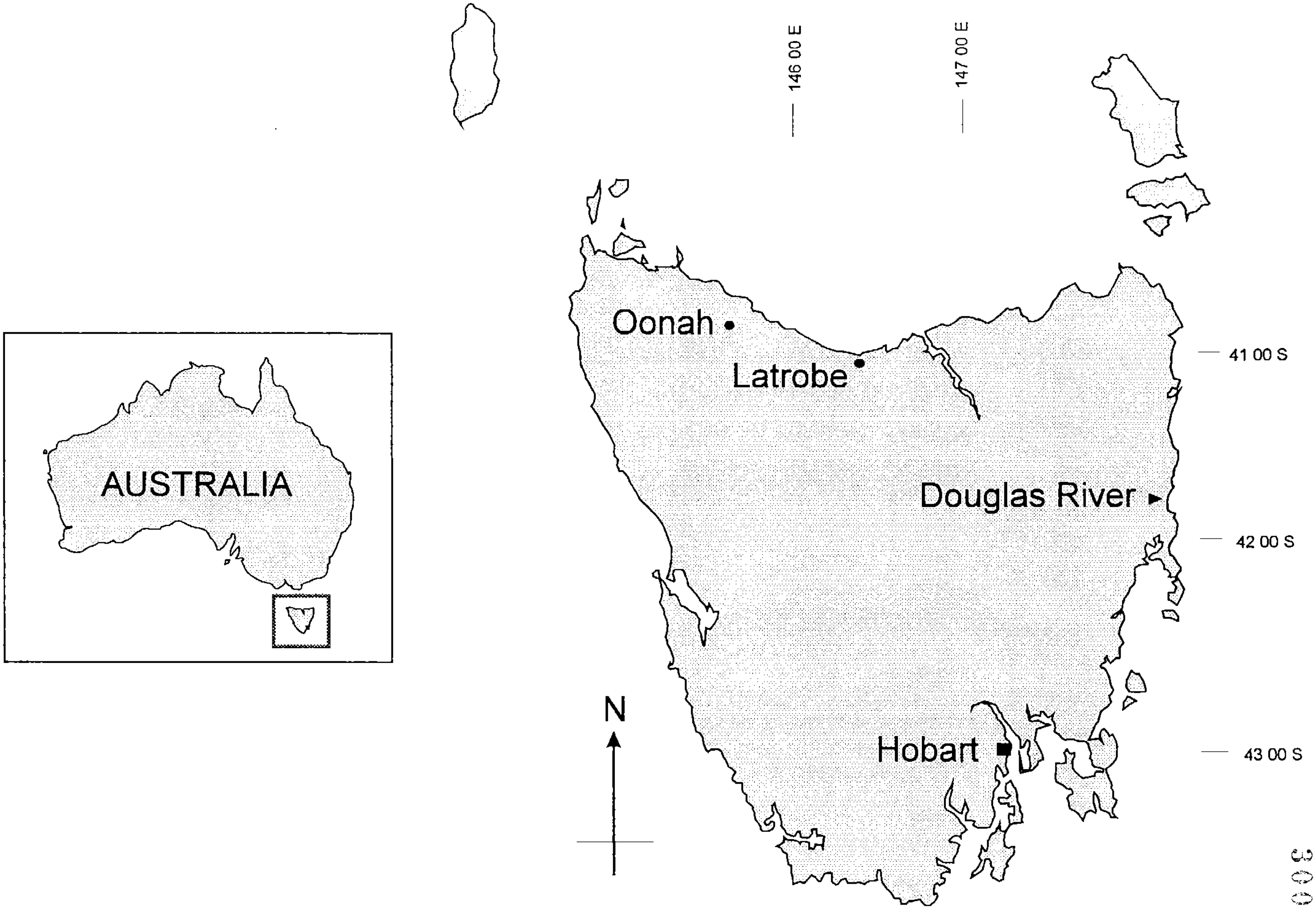
Fig. 16. Plot showing the variation in $\delta^{13}C$ values for kerogen and for *n*-alkanes, tricyclic compounds and aromatic derivatives vs. carbon number. Data from this study are represented as: -■- Latrobe; -O- Oonah; -□- Douglas River; and -x- Sea-ice diatoms. Data previously reported by Simoneit et al. (1993) are represented as -●-. Groups of compounds are indicated as *n*-alkanes and cyclic compounds (tricyclic alkanes and aromatic derivatives). Numerals refer to structures in scheme 1, tricyclic alkanes are all of type I. Note that the $\delta^{13}C$ values of kerogen from Latrobe and Oonah are almost identical.

Fig. 17. Gas chromatograms showing the aliphatic hydrocarbons from (a) the original extract and from closed-system pyrolysis of tasmanite kerogen, isolated from a sample collected at Latrobe, at (b) 300 °C, (c) 330 °C and (d) 350 °C. Note the progressive increase in low molecular weight *n*-alkanes and the relative decrease in tricyclic compounds.

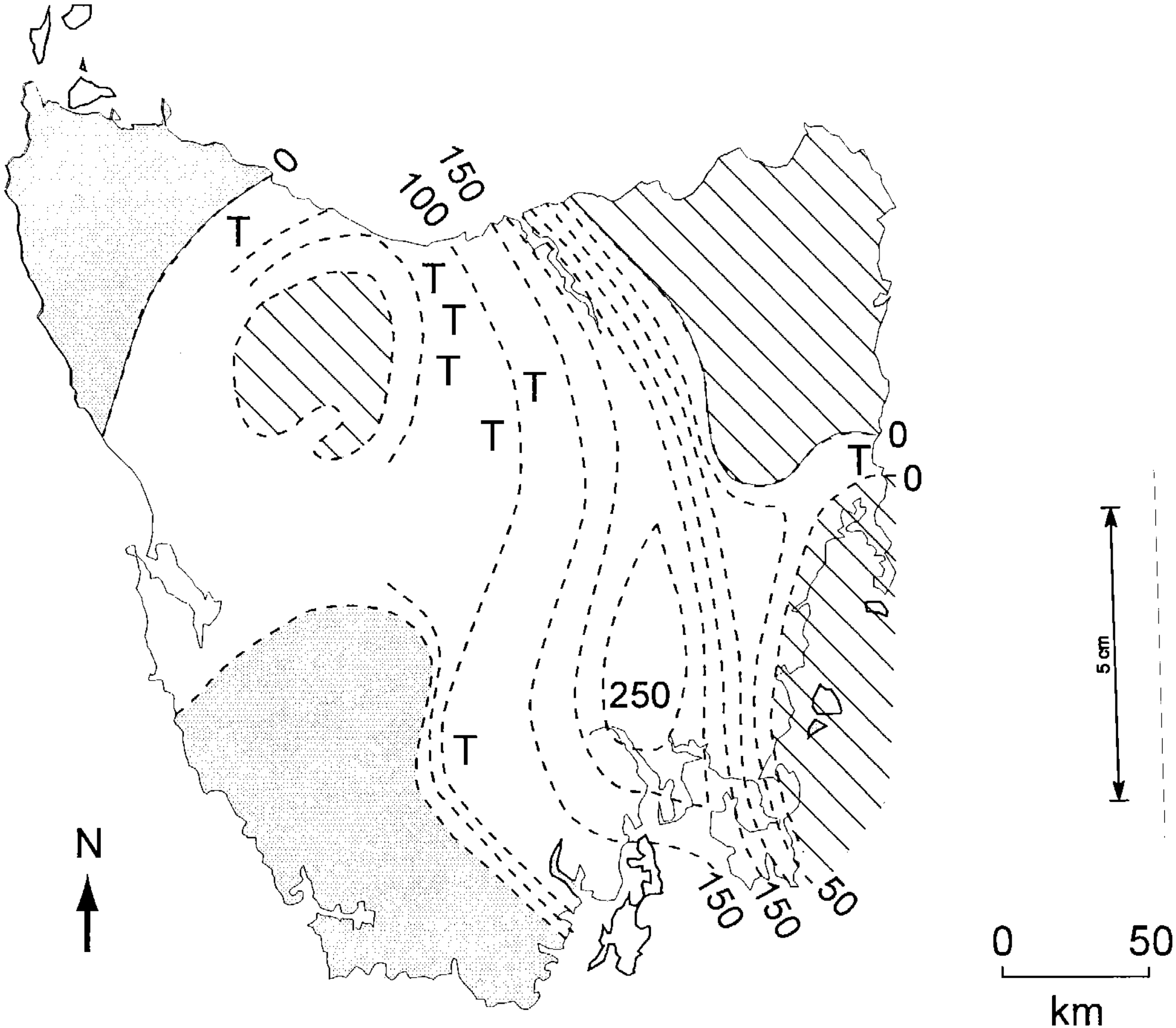
Fig. 18. Chart showing the $\delta^{13}C$ values of:

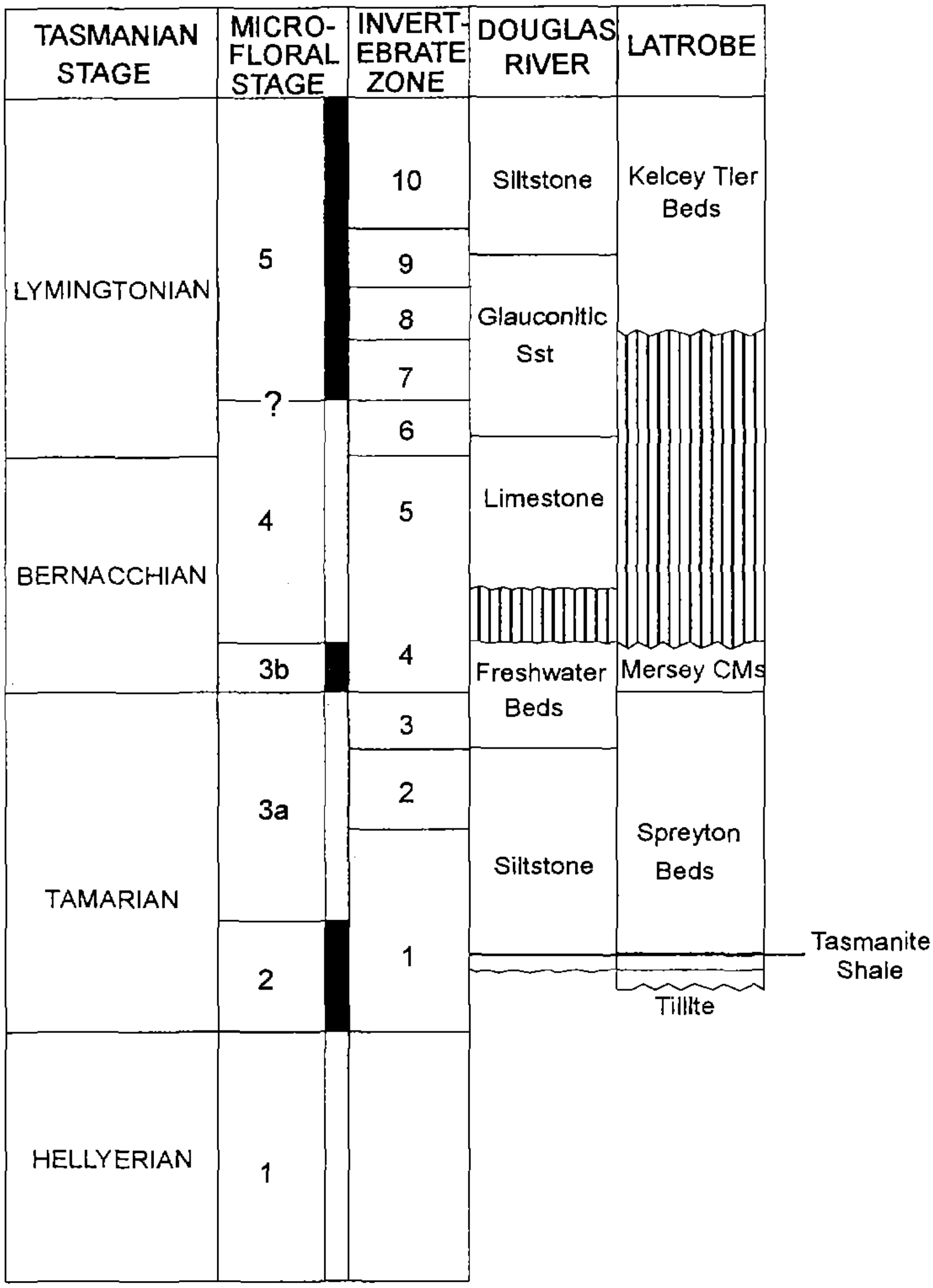
a) *n*-alkanes liberated by pyrolysis at 300 °C -◇-, 330 °C -◆- and 350 °C -□- of tasmanite kerogen from Latrobe (AGSO sample # 1995), compared with the original extract -■-.

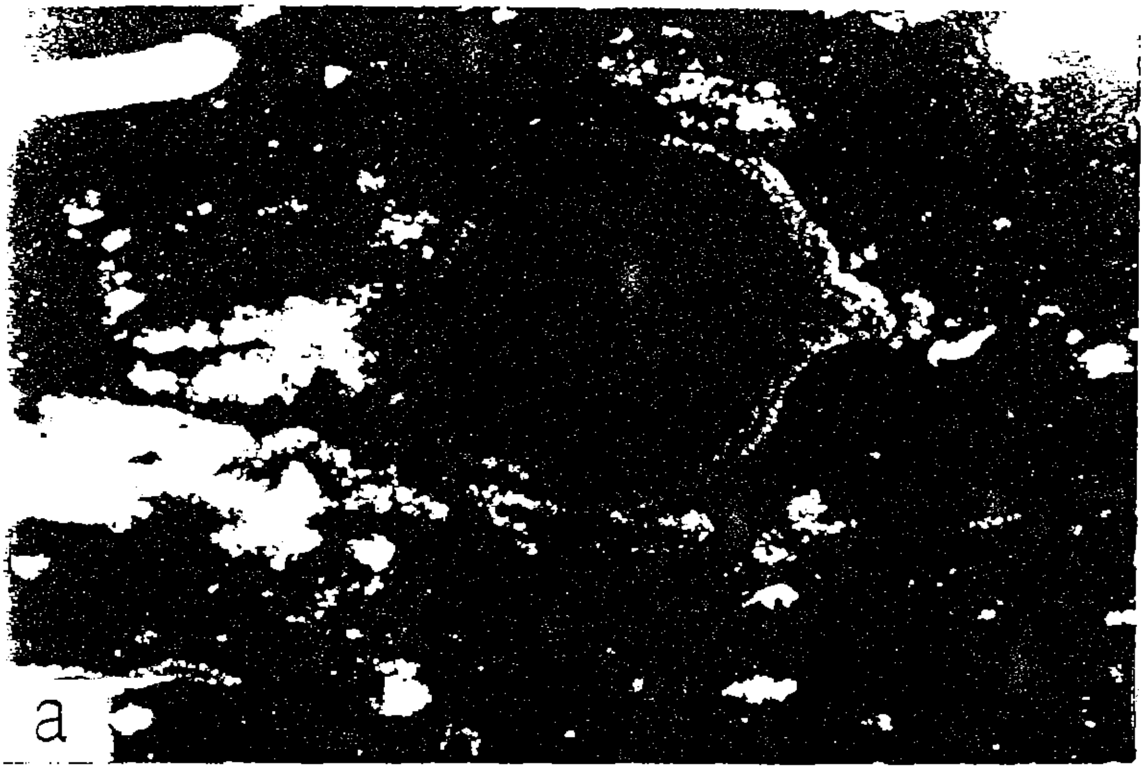
b) tricyclic hydrocarbons (structures I-VII in scheme 1) from Latrobe (extract and pyrolysate, symbols as in (a)).

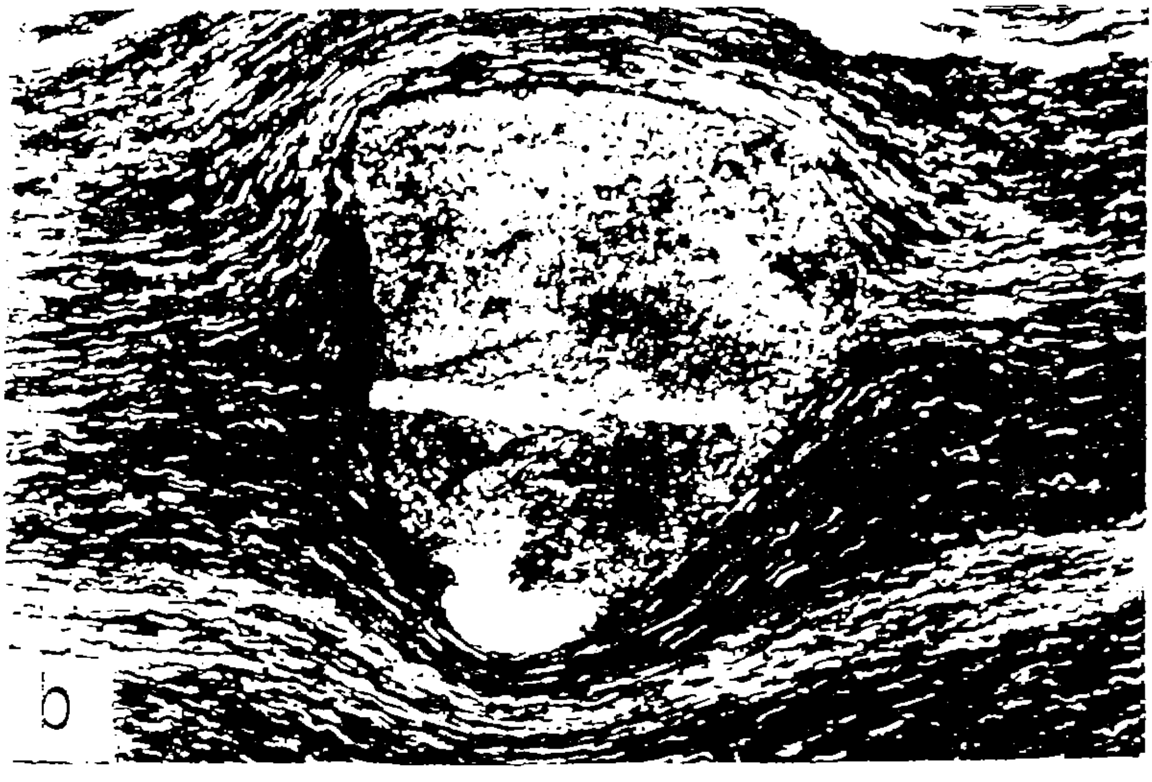


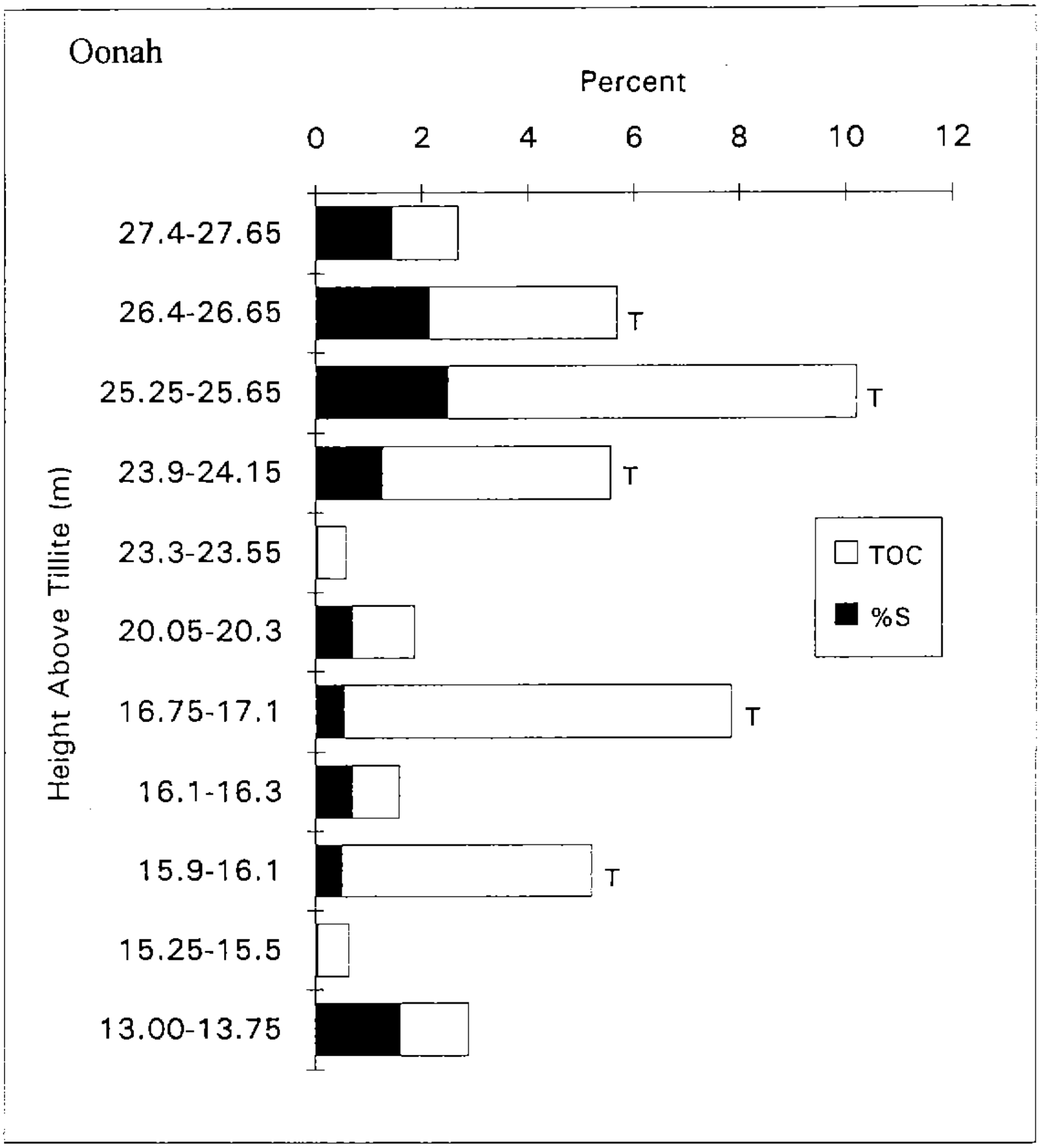
AUSTRALIA
146 00 E
147 00 E
Oonah
Latrobe
41 00 S
Douglas River
42 00 S
N
Hobart
43 00 S

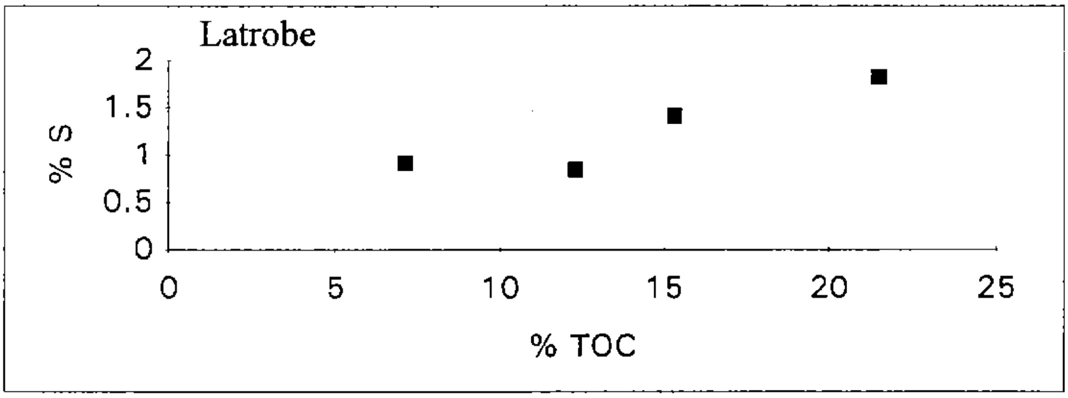

0
150
100
T
T
T
T
T
T
250
T
T
0
0
150
150
50
N
5 cm
0
50
km

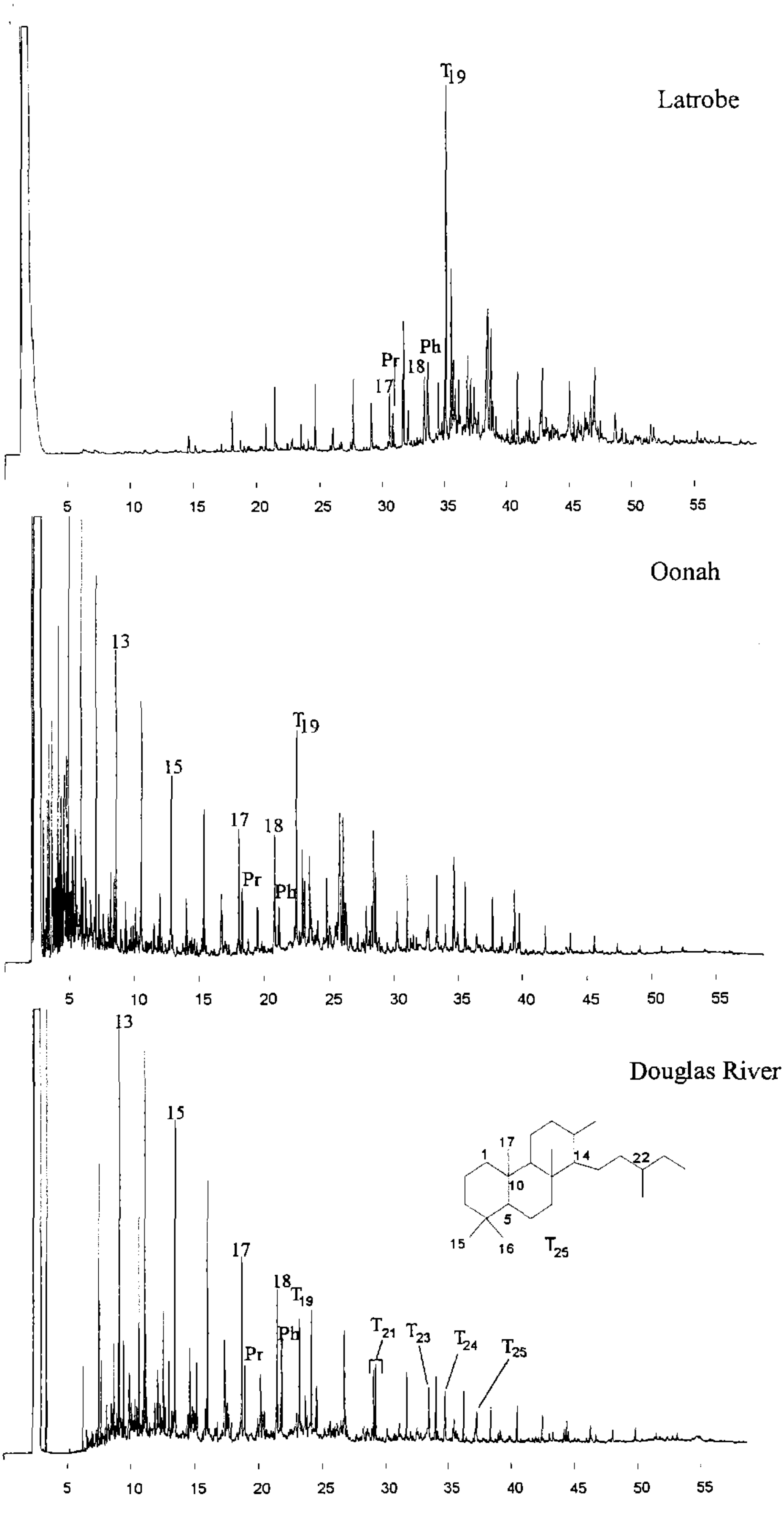

TASMANIAN STAGE
MICRO-FLORAL STAGE
INVERT-EBRATE ZONE
DOUGLAS RIVER
LATROBE
LYMINGTONIAN
BERNACCHIAN
TAMARIAN
HELLYERIAN
5
?
4
3b
3a
2
1
10
9
8
7
6
5
4
3
2
1
Siltstone
Glauconitic Sst
Limestone
Freshwater Beds
Siltstone
Kelcey Tier Beds
Mersey CMs
Spreyton Beds
Tasmanite Shale
Tillite



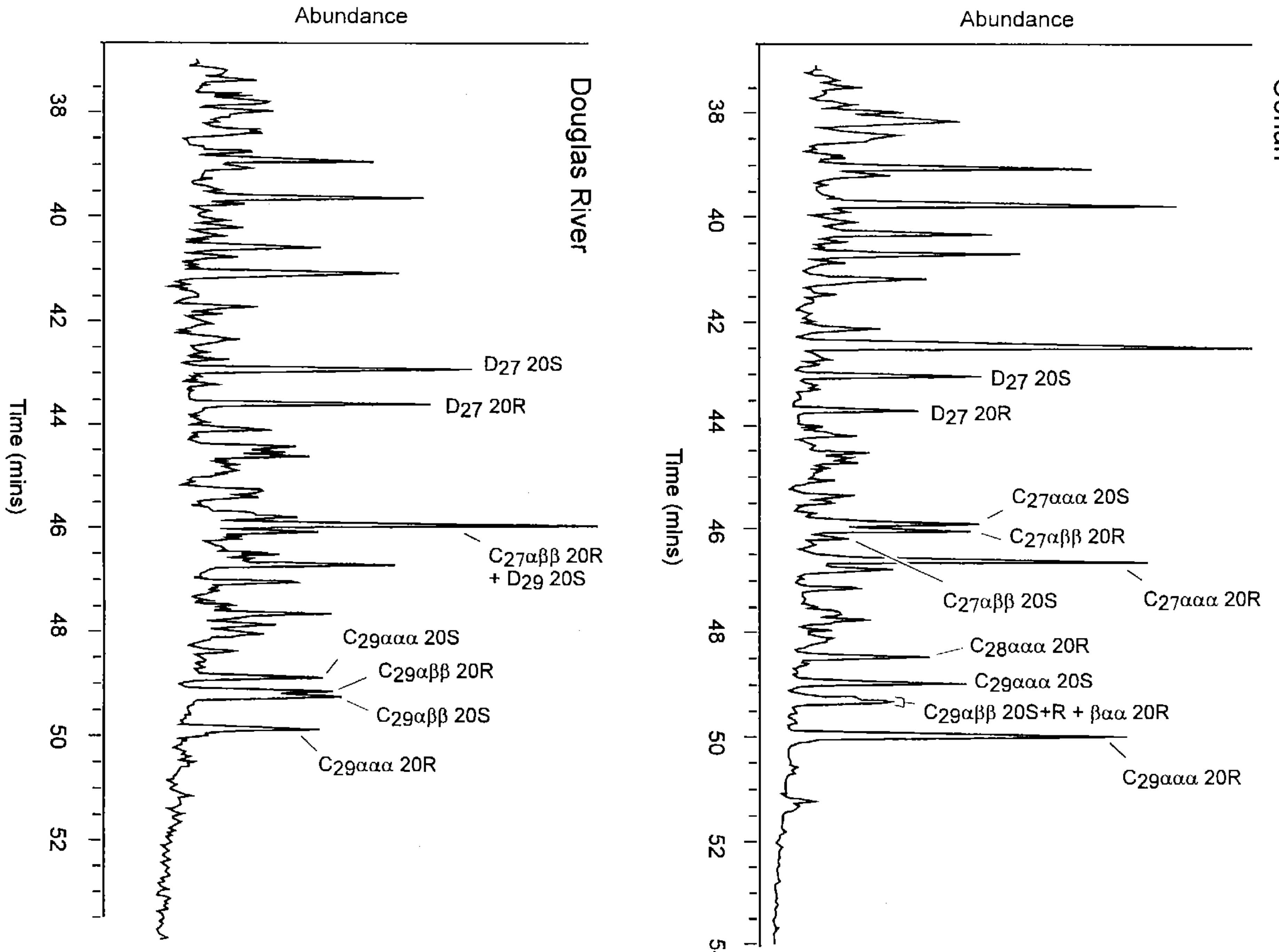



Oonah
Percent
0
2
4
6
8
10
12
Height Above Tillite (m)
27.4-27.65
26.4-26.65
25.25-25.65
23.9-24.15
23.3-23.55
20.05-20.3
16.75-17.1
16.1-16.3
15.9-16.1
15.25-15.5
13.00-13.75
T
T
T
T
T
TOC
%S

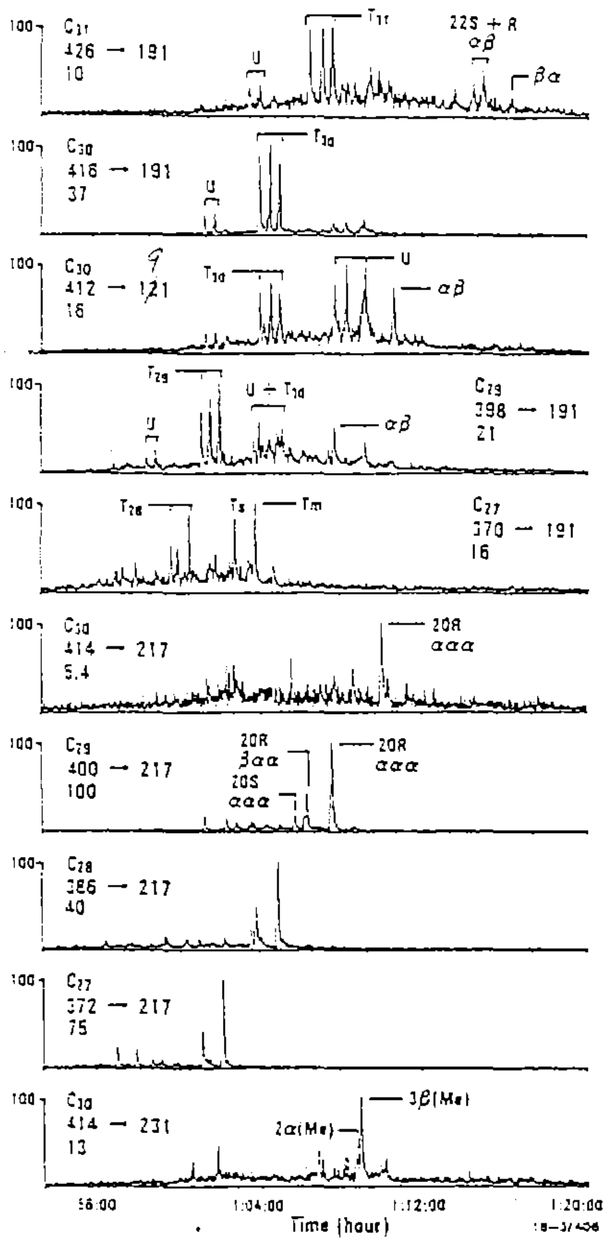

Latrobe
% S
2
1.5
1
0.5
0
0
5
10
15
20
25
% TOC

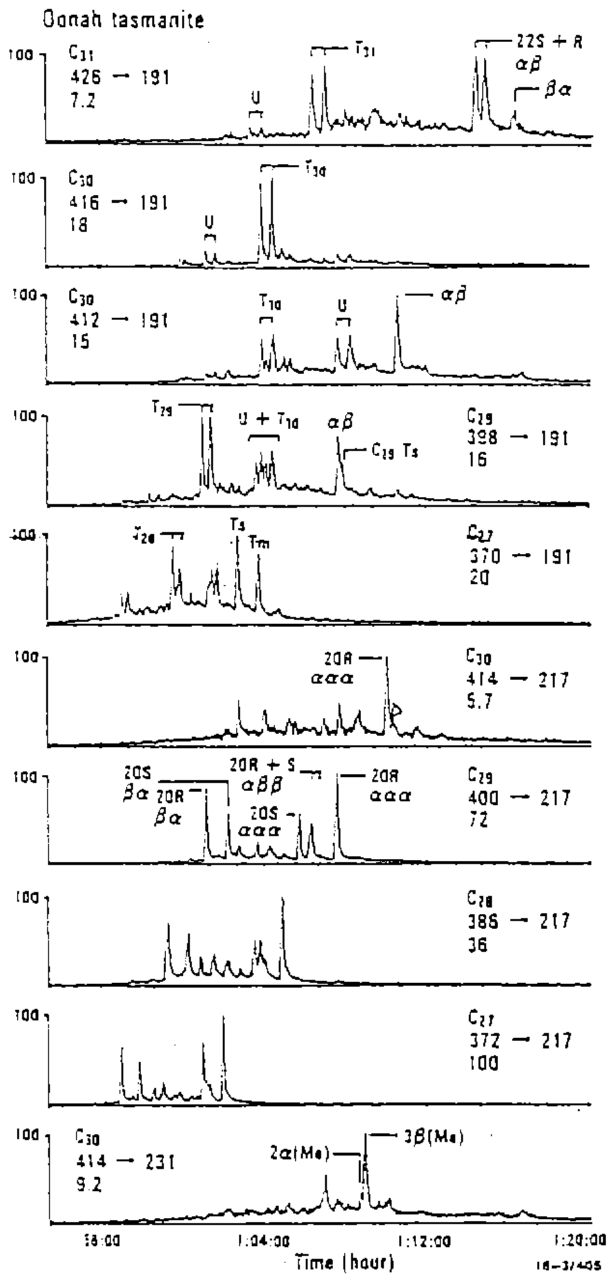


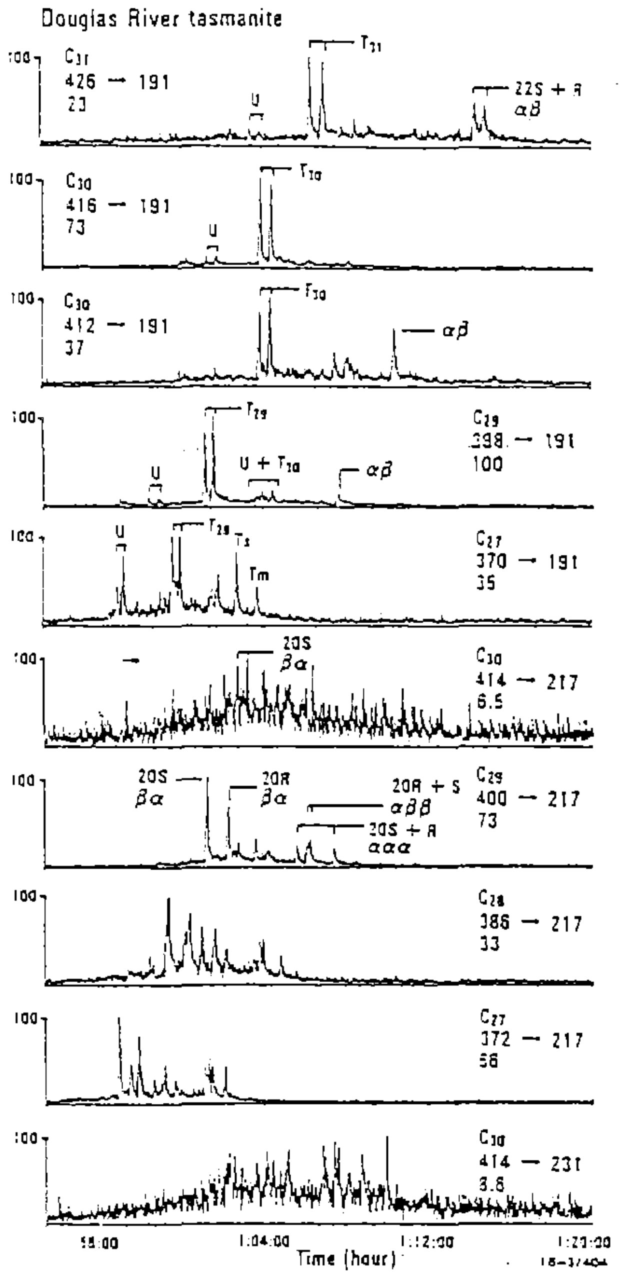
Latrobe
T19
Pr
17
18
Ph
5 10 15 20 25 30 35 40 45 50 55
Oonah
13
15
17
18
T19
Pr
Ph
5 10 15 20 25 30 35 40 45 50 55
Douglas River
13
15
17
18
T19
Ph
Pr
T21
T23
T24
T25
1
17
14
22
10
5
15
16
T25
5 10 15 20 25 30 35 40 45 50 55


Abundance
Douglas River
Time (mins)
38
40
42
44
46
48
50
52
D27 20S
D27 20R
C27αββ 20R + D29 20S
C29ααα 20S
C29αββ 20R
C29αββ 20S
C29ααα 20R
Abundance
Oonah
Time (mins)
38
40
42
44
46
48
50
52
54
D27 20S
D27 20R
C27ααα 20S
C27αββ 20R
C27αββ 20S
C27ααα 20R
C28ααα 20R
C29ααα 20S
C29αββ 20S+R + βαα 20R
C29ααα 20R

AGSO #1995 Latrobe tasmanite




Oonah tasmanite
C_{31} 426 → 191 7.2
C_{30} 416 → 191 18
C_{30} 412 → 191 15
C_{29} 398 → 191 16
C_{27} 370 → 191 20
C_{30} 414 → 217 5.7
C_{29} 400 → 217 72
C_{28} 386 → 217 36
C_{27} 372 → 217 100
C_{30} 414 → 231 9.2
22S + R αβ
βα
Ts
Tm
20R ααα
20R + S αββ
20S βα
20R βα
20S ααα
2α(Me)
3β(Me)
58:00
1:04:00
1:12:00
1:20:00
Time (hour)
16-3/405


Douglas River tasmanite
C31
426 → 191
23
C30
416 → 191
73
C30
412 → 191
37
C29
398 → 191
100
C27
370 → 191
35
C30
414 → 217
6.5
C29
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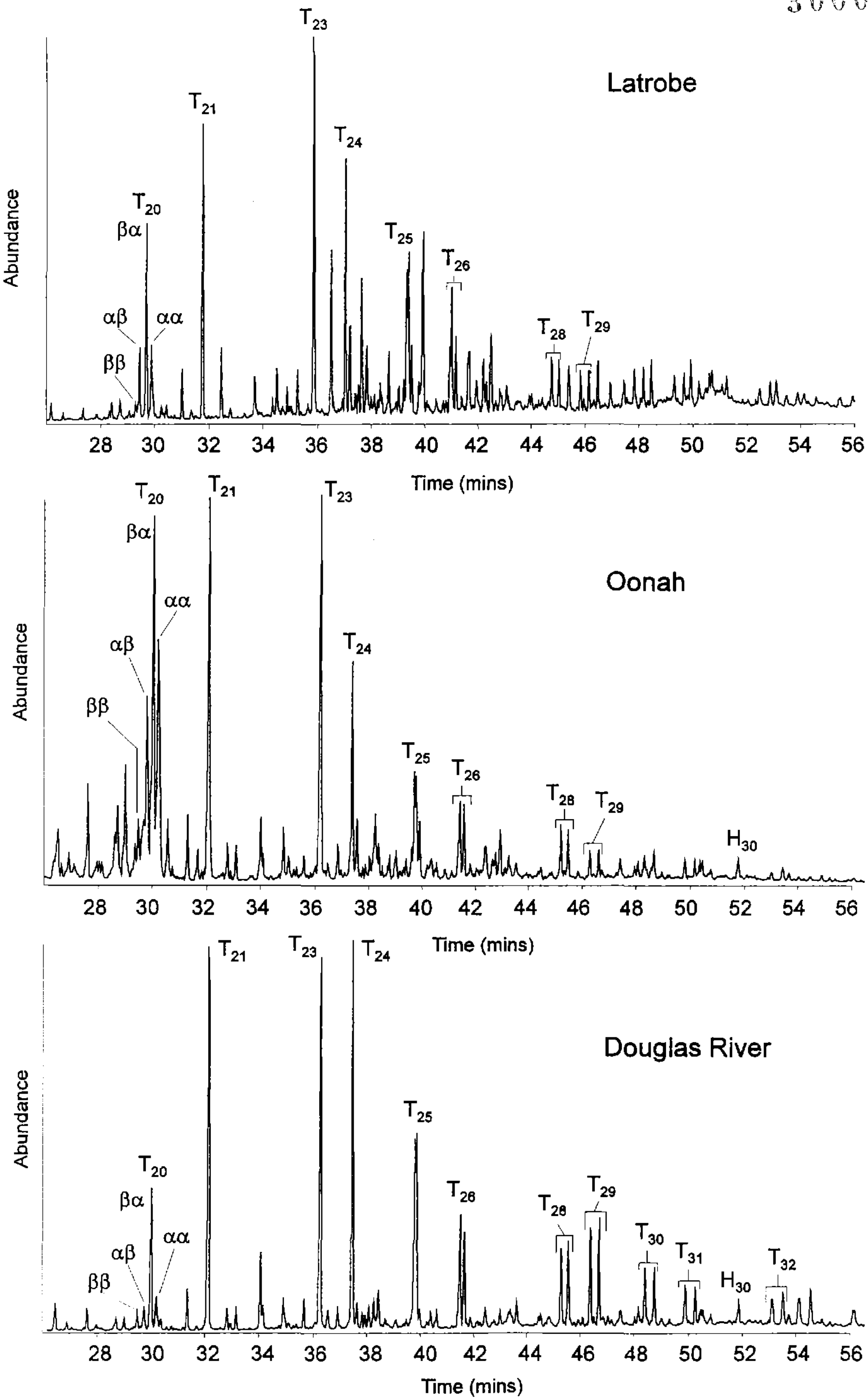
73
C28
386 → 217
33
C27
372 → 217
56
C30
414 → 231
3.6
Time (hour)


Latrobe
Abundance
Time (mins)
T20
T21
T23
T24
T25
T26
T28
T29
βα
αβ
αα
ββ
Oonah
Abundance
Time (mins)
T20
T21
T23
T24
T25
T26
T28
T29
H30
βα
αβ
αα
ββ
Douglas River
Abundance
Time (mins)
T20
T21
T23
T24
T25
T26
T28
T29
T30
T31
T32
H30
βα
αβ
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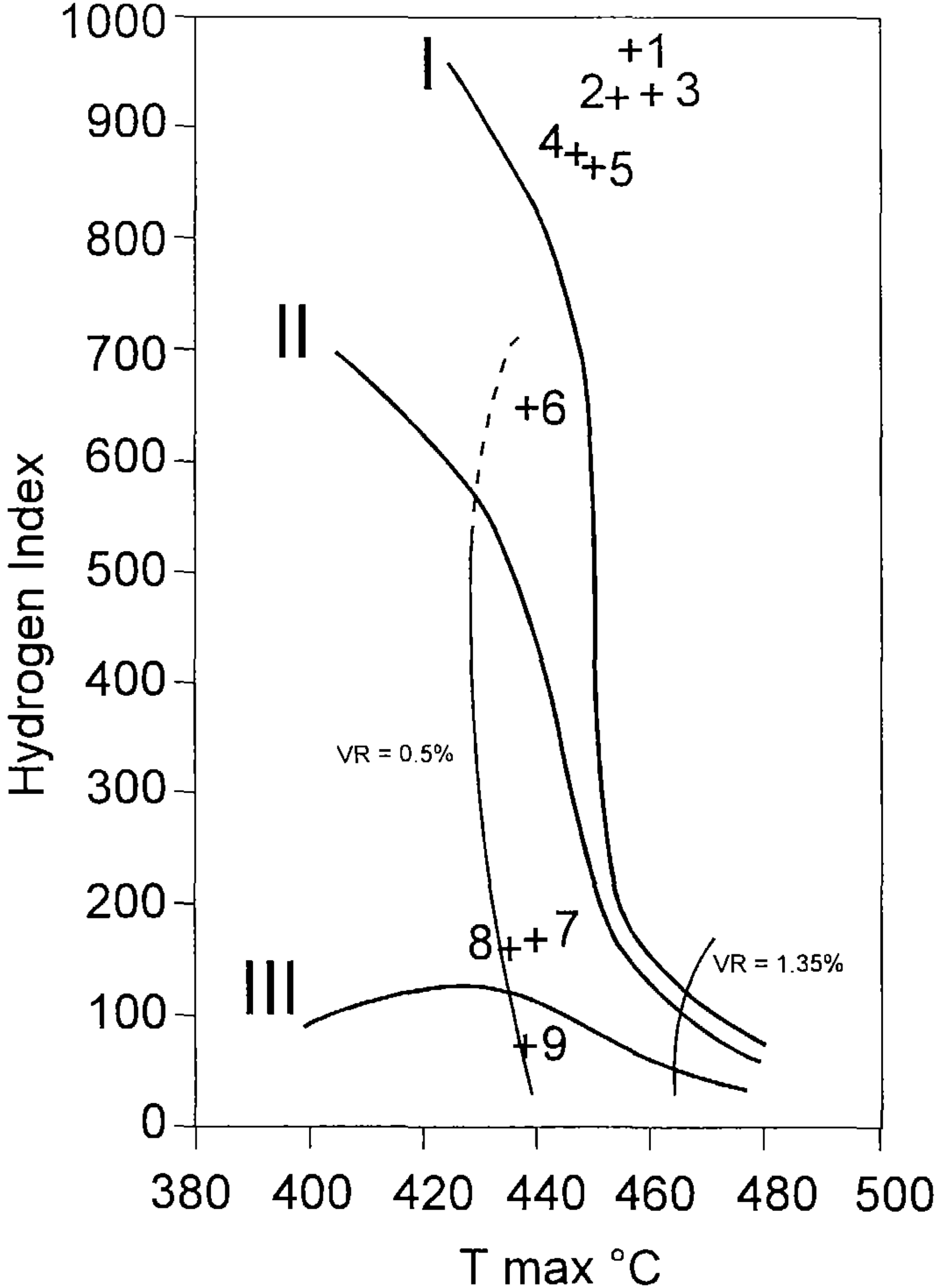
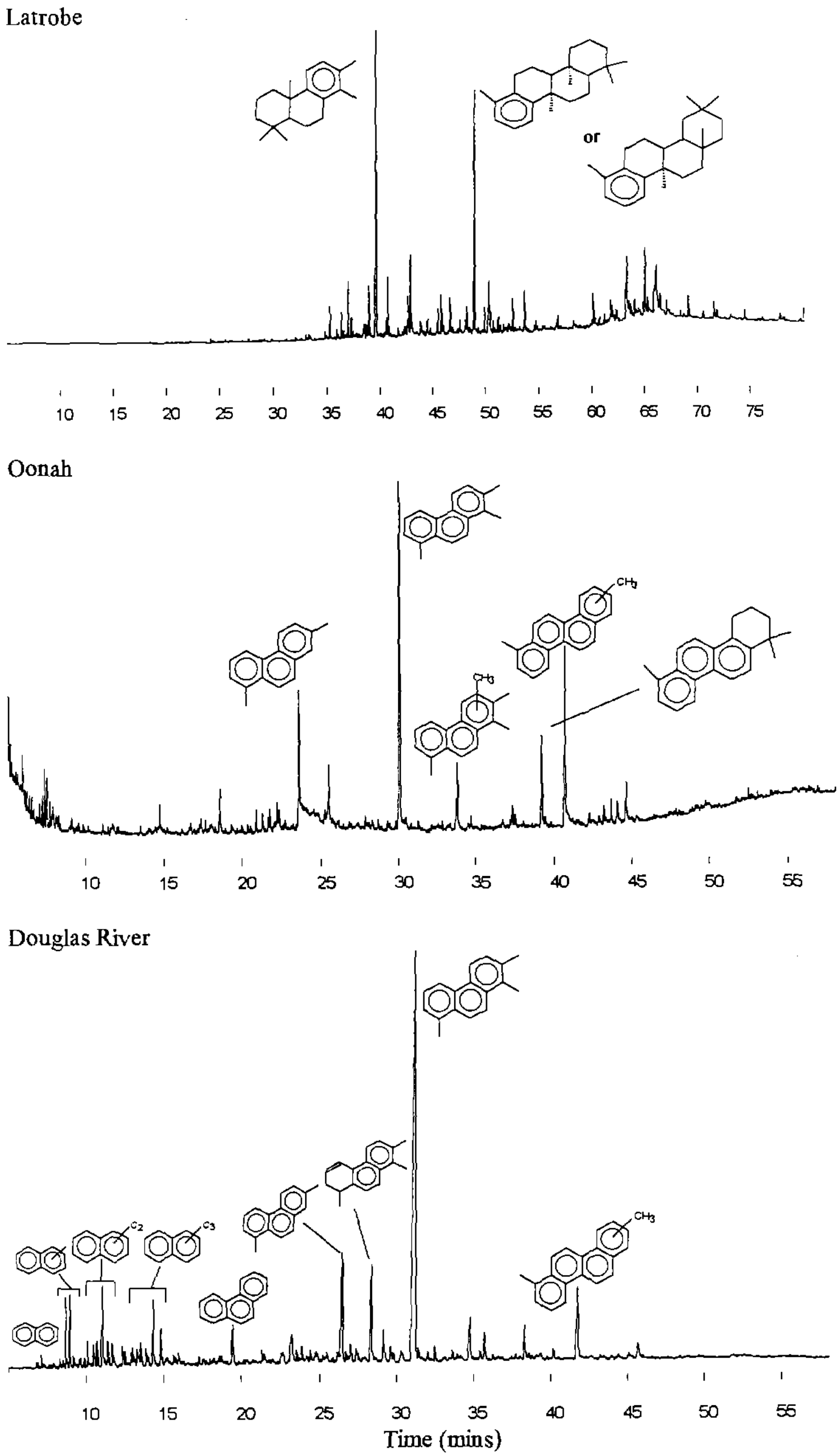
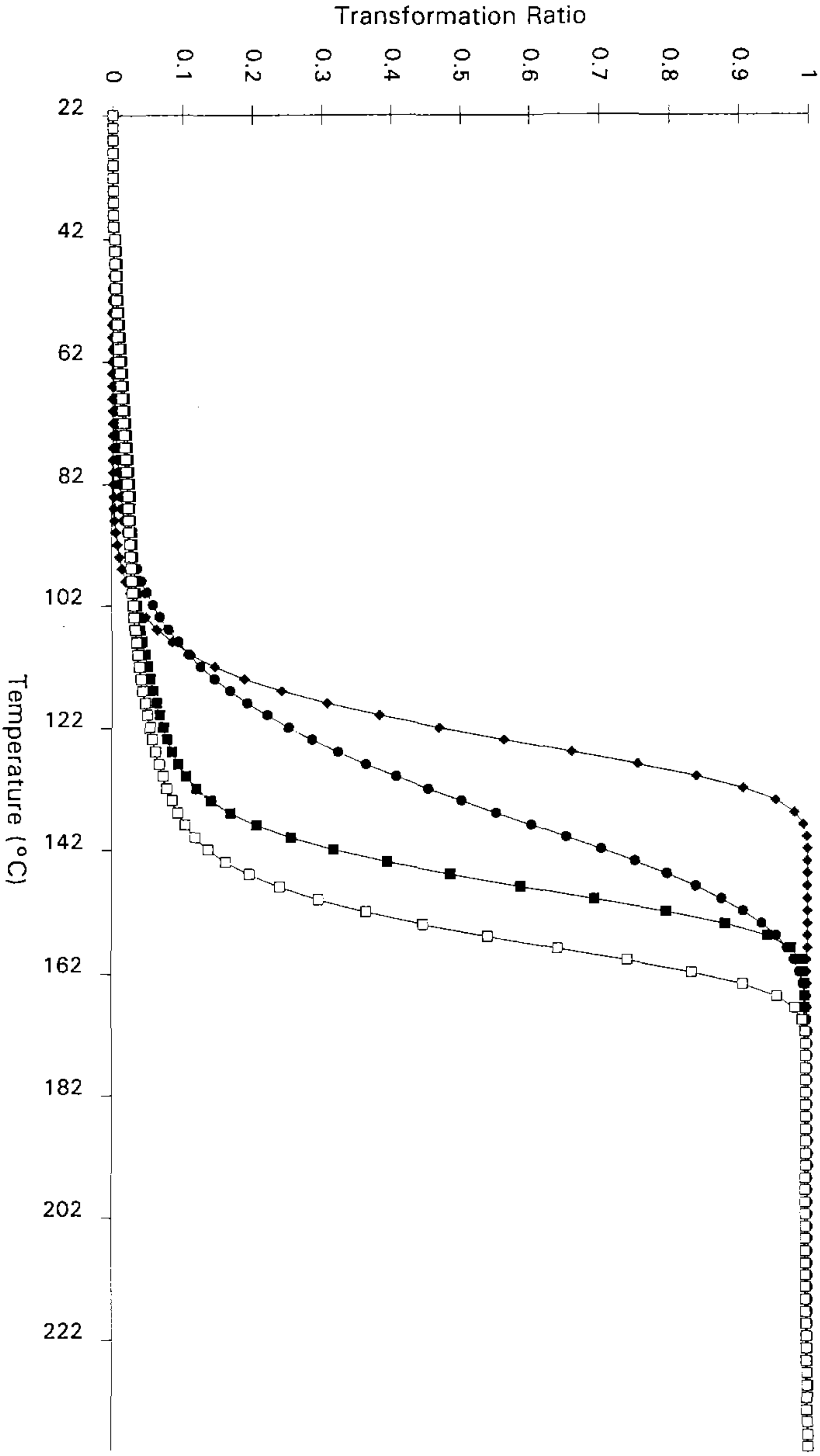
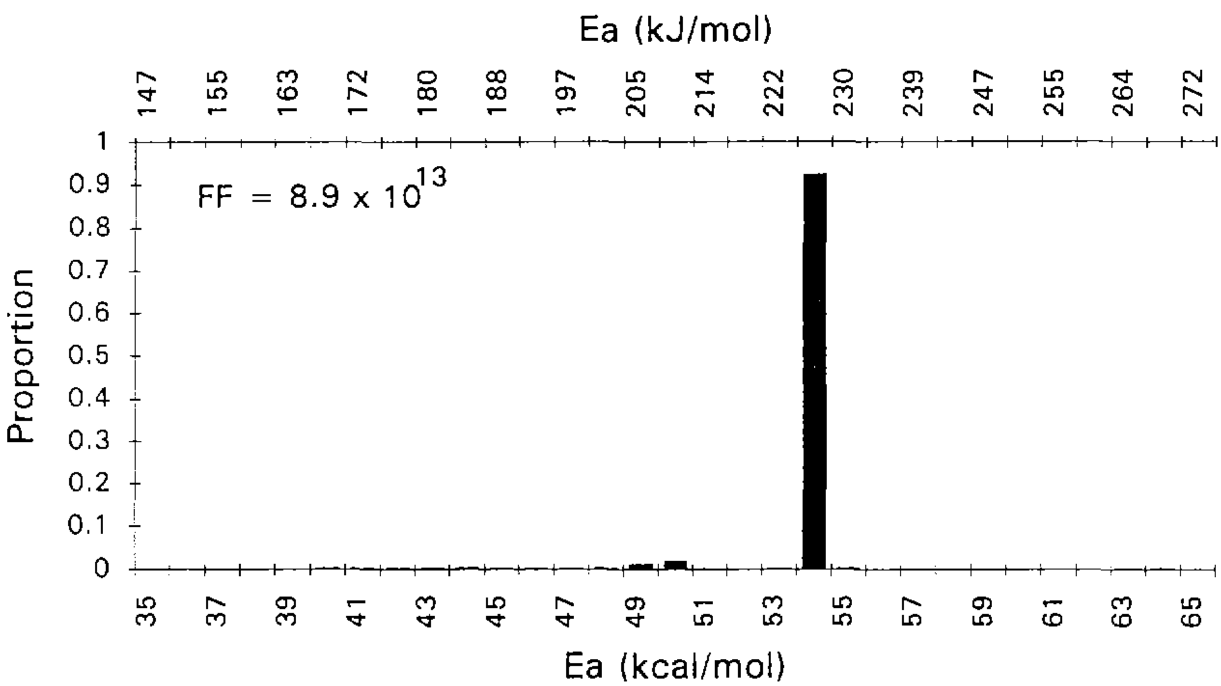
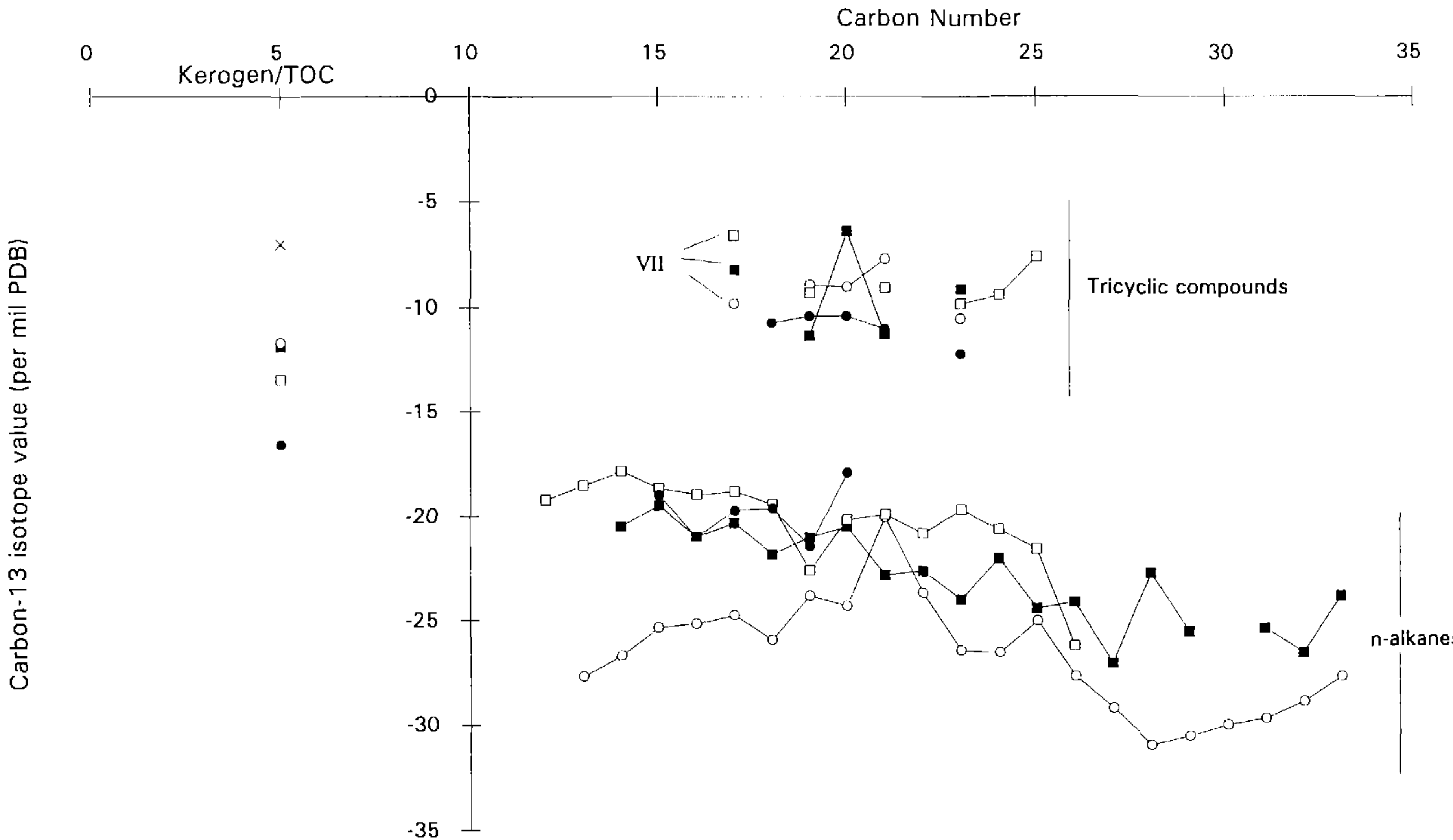
28 30 32 34 36 38 40 42 44 46 48 50 52 54 56

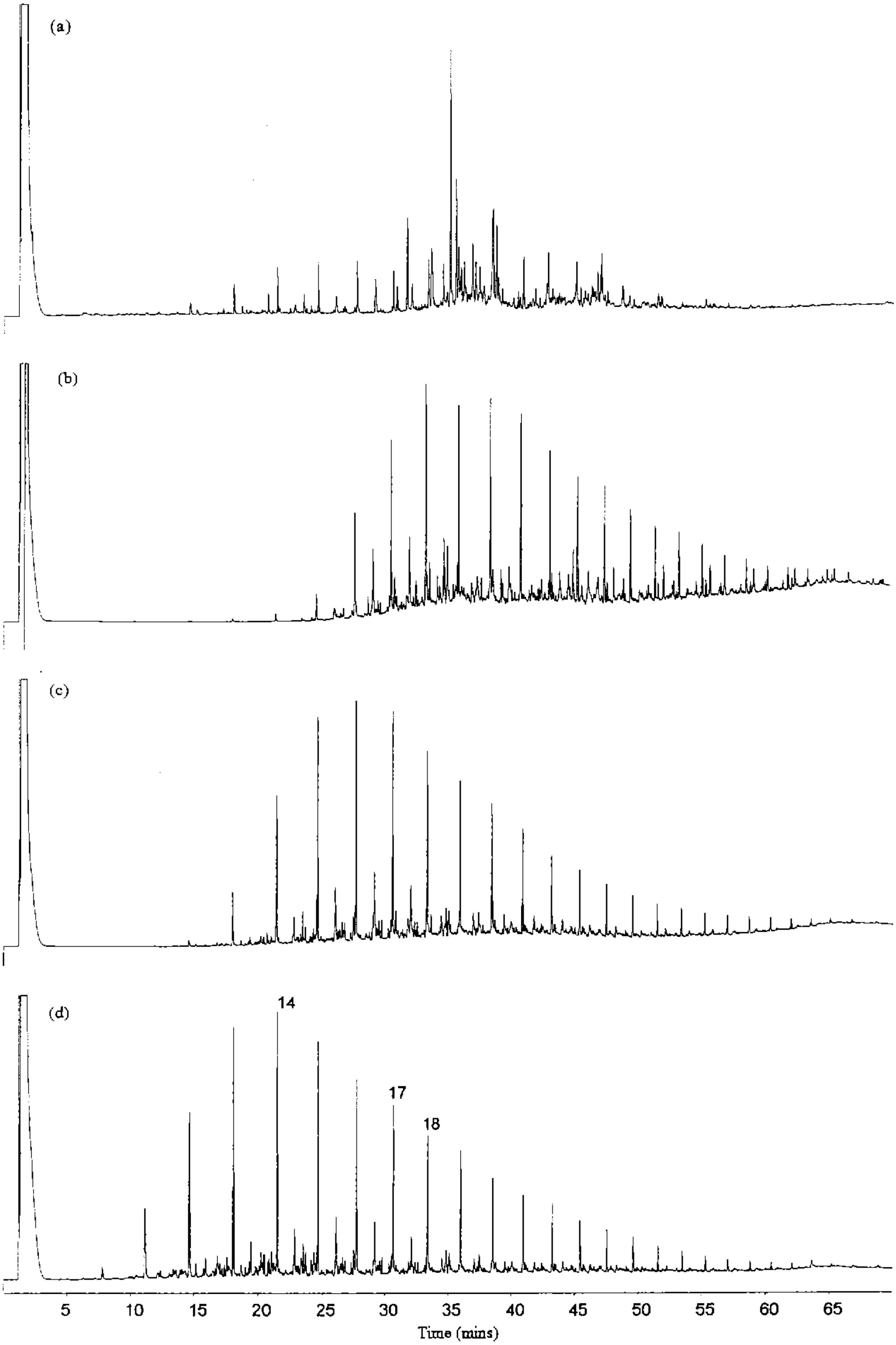

Hydrogen Index
T max °C
I
II
III
+1
2+ +3
4+ +5
+6
8+ +7
+9
VR = 0.5%
VR = 1.35%
0
100
200
300
400
500
600
700
800
900
1000
380
400
420
440
460
480
500

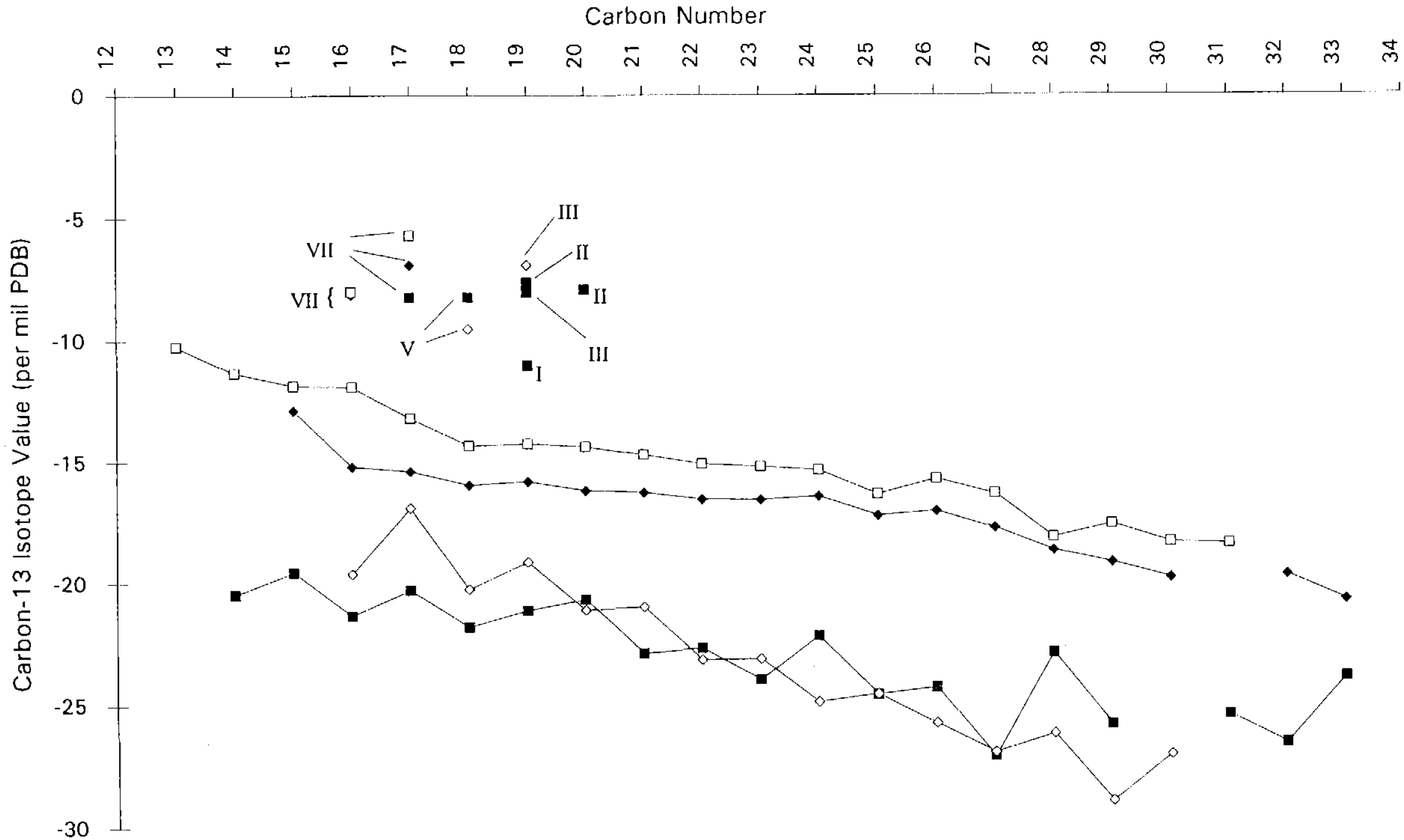

Latrobe
or
10 15 20 25 30 35 40 45 50 55 60 65 70 75
Oonah
CH3
10 15 20 25 30 35 40 45 50 55
Douglas River
C2
C3
CH3
10 15 20 25 30 35 40 45 50 55
Time (mins)


Transformation Ratio
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Temperature (°C)
22
42
62
82
102
122
142
162
182
202
222


Ea (kJ/mol)
147
155
163
172
180
188
197
205
214
222
230
239
247
255
264
272
Proportion
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
FF = 8.9 x 10^13
35
37
39
41
43
45
47
49
51
53
55
57
59
61
63
65
Ea (kcal/mol)

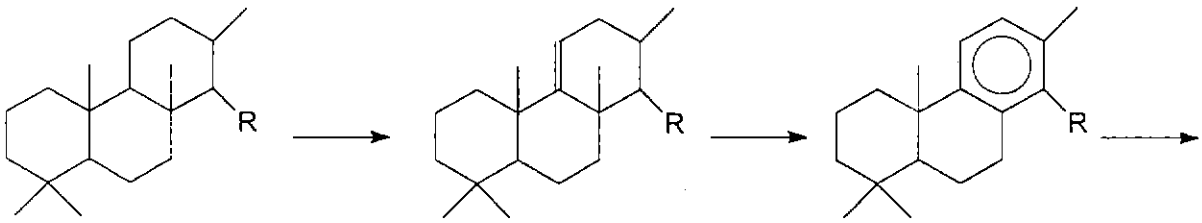

Carbon Number
0
5
10
15
20
25
30
35
Kerogen/TOC
Carbon-13 isotope value (per mil PDB)
0
-5
-10
-15
-20
-25
-30
-35
VII
Tricyclic compounds
n-alkanes


(a)
(b)
(c)
(d)
14
17
18
5
10
15
20
25
30
35
40
45
50
55
60
65
Time (mins)



Carbon Number
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
0
-5
-10
-15
-20
-25
-30
Carbon-13 Isotope Value (per mil PDB)
VII
VII {
V
III
II
II
III
I

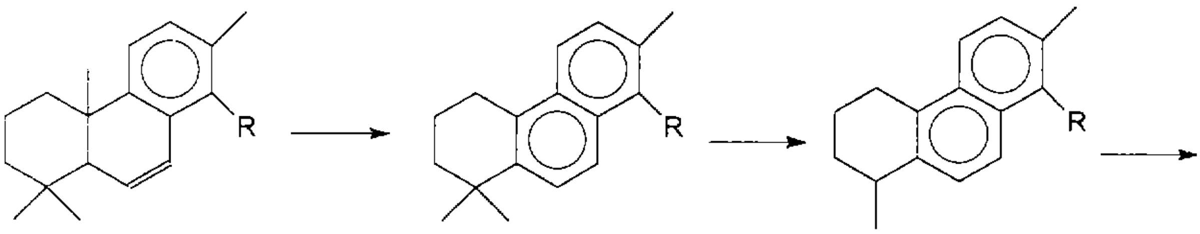
Scheme 1



I — $\delta^{13}C$ = -11 ‰ to -6.4 ‰, mean = -8 ‰

II — $C_{19:4}$ -7.6 ‰, $C_{20:4}$ -7.2 ‰

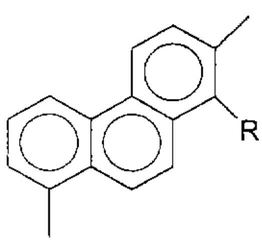
III — $C_{19:6}$ -8.6 ‰ to -7.0 ‰



IV — $C_{19:7}$

V — $C_{18:8}$ -9.5 ‰ to -8.1 ‰

VI — $C_{17:9}$ -8.1 ‰



VII — $C_{16:10}$ -8.3 ‰ to -7.6 ‰, $C_{17:10}$ -9.8 ‰ to -6.0 ‰

Proposed general scheme for tricyclic compound aromatisation. R = H or alkyl chain, Cn:x, n = carbon number, x = rings + double bonds. Compound IV could be identified but no isotopic data could be obtained. Compounds I, III and V-VII had mass spectra comparable to published data. For type II ($C_{19:4}$) M^+ 260 (27 %), 245 (100), 189 (8), 175 (29), 163 (15), 149 (67), 119 (21); type IV ($C_{19:7}$) M^+ 254 (35), 239 (45), 183 (42), 169 (100).

Appendix (2)

300065

CSIRO

Marine Laboratories

Condor-94-1

ANALYSIS OF SAMPLES FROM BRUNY ISLAND FOR PETROLEUM HYDROCARBONS

Prepared by: A.T. Revill and J.K. Volkman
CSIRO Division of Oceanography

Prepared for: Condor Oil Investments Pty. Ltd., Tasmania

Attention: Mr. Malcolm Bendall
Managing Director

December 22, 1994

Australian Science, Australia's Future

CSIRO
AUSTRALIA

INTRODUCTION

In November 1994, as part of the on-going investigation into the possible occurrence of petroleum hydrocarbons on-shore in Tasmania, Condor Oil Investments Pty. Ltd. commenced drilling two stratigraphic boreholes on Bruny Island, named SHITTIM 1 and GILGAL 1. During the course of drilling both holes suffered an in-flow of gas and SHITTIM 1 also began to yield a hot brine at a depth of 64 metres at an estimated rate of 7000 gallons per hour. Drilling on both sites was stopped and samples taken for analyses.

SAMPLES

The following samples were delivered to the CSIRO Marine Laboratories for hydrocarbon analysis:

Two samples of brine and a clay sample from the base of GILGAL 1
Two samples of brine from SHITTIM 1
Three water samples from a saw pit bubbling gas

One sample of the brine from SHITTIM 1, and the clay from GILGAL 1 were analysed for hydrocarbons. Of the samples from the saw pit, two were heavily contaminated by organic (plant) matter and so were deemed unsuitable for hydrocarbon analysis. The third sample was clear of this matter, having been "concentrated" by Mr. Bendall, and it was decided to analyse this sample.

On a subsequent trip to Bruny Island (7/12/94) Dr. Revill collected gas samples from SHITTIM 1, GILGAL 1, Johnstones well and the saw pit. These were sent to AGSO for gas analysis.

ANALYSIS

The water samples to be analysed were transferred to a separating funnel and solvent extracted with hexane (2 x 75 ml), the solvent fractions combined and reduced under vacuum to a volume of 50 µl.

The clay sample (131 g wet weight) was extracted by ultrasonication (2 x 5 minutes, stirring in between) with 50 ml of methanol, the solvent transferred to centrifuged tubes and centrifuged at 2000 rpm for 10 minutes. The supernatant was decanted into a separating funnel containing water (milli-Q) and the sediment re-combined with the original. The extraction was then repeated with solvent mixtures of decreasing polarity (chloroform:methanol, 7:3, 4:1; chloroform) and the extracts combined. The chloroform fraction was collected, reduced under vacuum, dried by passing through anhydrous sodium sulphate and transferred to a vial and further reduced to 50 µl. The sediment was air dried and re-weighed to obtain a dry weight.

The solvent extracts were analysed by gas chromatography (GC) and gas chromatography-mass spectrometry (GC-MS) operating in the Selected Ion Recording (SIR) mode.

Gas samples were collected by displacing water (milli-Q) from a gas tight PET plastic bottle.

RESULTS

Gas Analyses

Results for the analysis of 4 gas samples are given in Table 1. No trace of methane was found in either SHITTIM 1 or GILGAL 1. Both the Saw Pit and Johnstones well samples contained methane and both had similar $\delta^{13}C$ isotope values of -56 ‰ and -55 ‰ respectively. Both these results are interpreted as being due to biogenic methane due to the lack of any higher homologues above C_1 and from the isotope values. The values of -55 ‰ and -56 ‰ are possibly regarded as "heavy" for biogenic samples but the environment from which they were collected (waterlogged sites with ample vegetable material) would be experiencing methane oxidation which in turn would lead to the slightly "heavy" values.

Saw Pit water sample

No evidence for hydrocarbons in this sample could be found either by GC or GC-MS (Figures 1-4).

SHITTIM 1 water sample

GC analysis of the water extract shows no detectable signs of hydrocarbons, however analysis by the much more sensitive SIR GC-MS suggests the presence of a restricted *n*-alkane profile (Figure 1) and hydrocarbon biomarkers can be detected (Figures 2-4). The presence of such a restricted *n*-alkane envelope is generally indicative of a refined petroleum product, in this case a "heavy diesel or gas oil" and the pristane/phytane ratio in this sample is commonly associated with oils derived from Bass Strait. However, the cyclic biomarker profiles contradict this and are more indicative of a mature Middle East derived oil, for example, the C_{29} hopane > C_{30} (Figure 2), low diasterane content (Figure 3) and the presence of methyl hopanes (Figure 4) generally taken to indicate a marine carbonate sourced oil. Thus in this sample there is a suggestion of a mixed source for the very low levels of hydrocarbons. These may be contamination from the drilling operations but this cannot be confirmed or eliminated unless samples of the lubricants used during the drilling operations are analysed.

GILGAL 1 clay sample

GC analysis of the total solvent extract from the clay sample (Figure 5) shows the clay to contain a slightly greater quantity of hydrocarbons than the SHITTIM 1 water, dominated by a high end unresolved complex mixture (UCM). The narrow carbon number range and GC elution time of this UCM is generally indicative of a refined product such as lubricating oils. GC analysis was unable to detect the *n*-alkane profile observed in the SHITTIM 1 water, but this may be due to material naturally present in the clay masking the signal. GC-MS analysis however does show the presence of a restricted *n*-alkane profile similar to that seen in the SHITTIM 1 water (Figure 1), with a similar pristane/phytane ratio. The cyclic biomarkers are again contradictory to the pristane/phytane ratio and similar to the SHITTIM 1 sample indicating a Middle East origin. It is reasonable to suppose in this sample that the cyclic biomarkers are associated with the UCM since these elute around the same retention time and the UCM is present in much larger quantities than the *n*-alkanes, thus the indication is that the hydrocarbons in SHITTIM 1 and GILGAL 1 share the same source(s). The inference at the present time, due to the restricted carbon number ranges of the *n*-alkanes and UCM, is that the

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It should also be pointed out that small amounts of hydrocarbons are found in most sediments. Even if the distributions found here are indigenous it may be that they have been produced by localised dolerite heating of organic matter.

CONCLUSIONS

- No methane was detected in samples from the two stratigraphic holes.
- Methane from the Saw Pit and Johnstone's well is interpreted as being biogenic in origin.
- No hydrocarbons could be detected in water from the Saw Pit and were detected in only very low amounts in water from SHITTIM 1. The clay sample from GILGAL 1 contained slightly higher levels of hydrocarbons.
- The hydrocarbons detected in both wells exhibited similar restricted *n*-alkane and biomarker profiles consistent with refined products but this cannot be confirmed without analysis of samples of lubricants and fuels used during drilling.

TABLE 1: Results of gas analysis on Bruny Island samples

Sample	Oxygen (%)	Nitrogen (%)	Carbon dioxide (%)	Methane (%)	$\delta^{13}C$ Methane (‰)
Saw Pit	1.1	37.5	7.1	54.3	-56.1
Johnstones Well	2.4	19.4	7.8	70.3	-55.2
SHITTIM 1	16.7	80.6	2.7	NIL	
GILGAL 1	21.8	77.8	0.4	NIL	

Calculated in Mole %; No C_2 to C_5 components detected.
Data provided by Dr. R. Summons, AGSO.

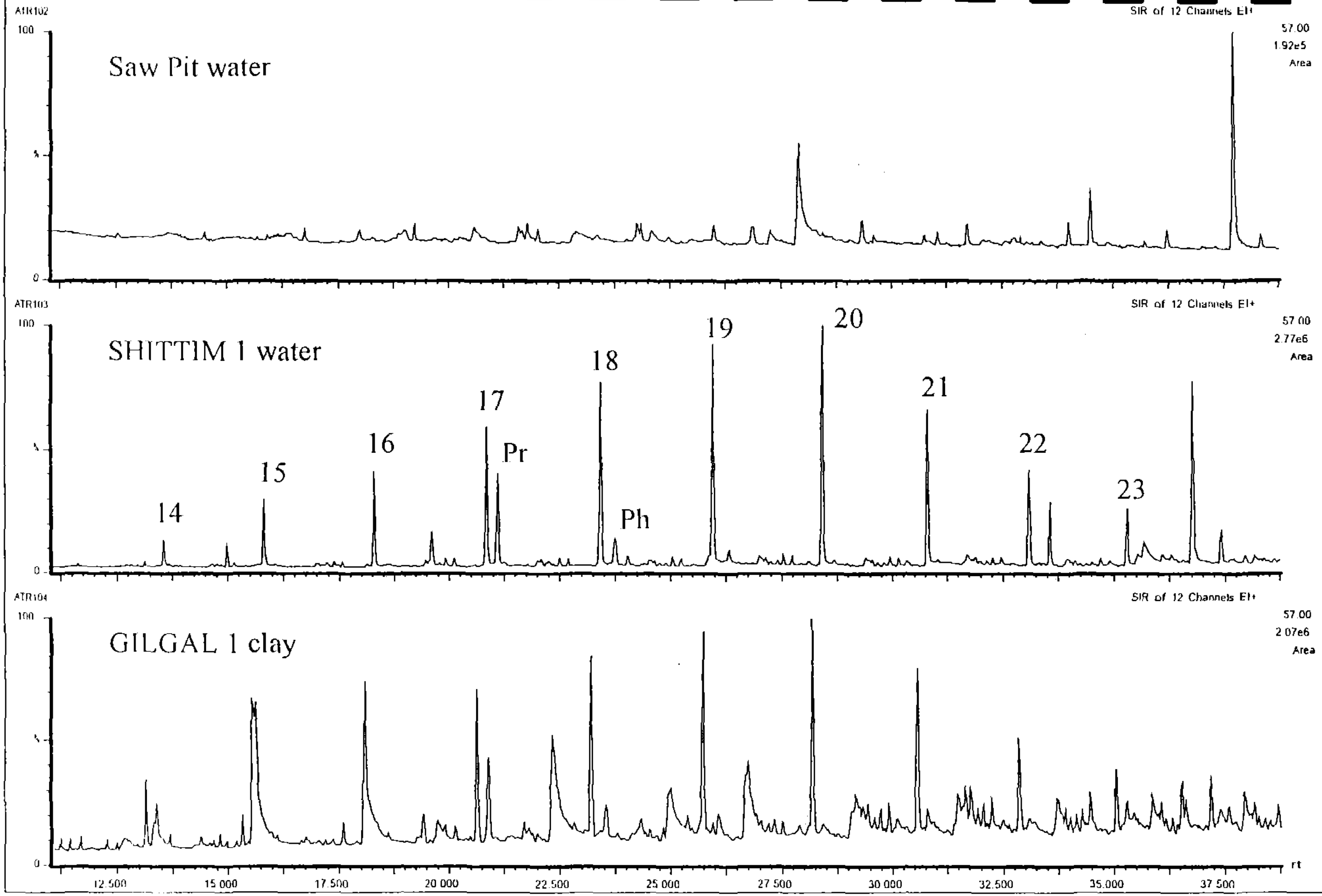


Figure 1: *m/z* 57 mass fragmentogram to highlight *n*-alkanes in the three samples analysed

(note that the clay sample contains non-hydrocarbon material in the total extract)

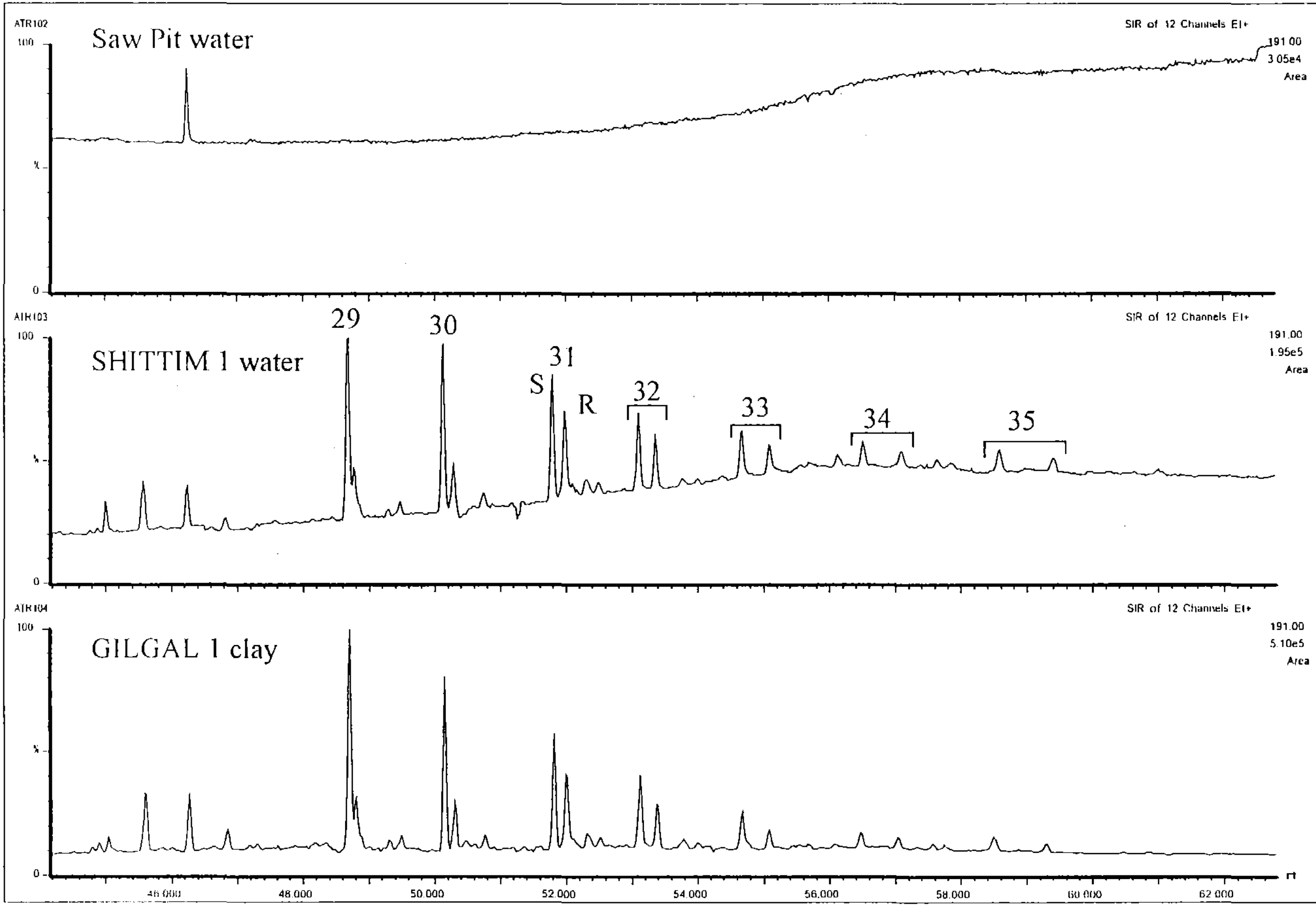


Figure 2: *m/z* 191 mass fragmentogram to show distribution of hopanes in the three samples analysed

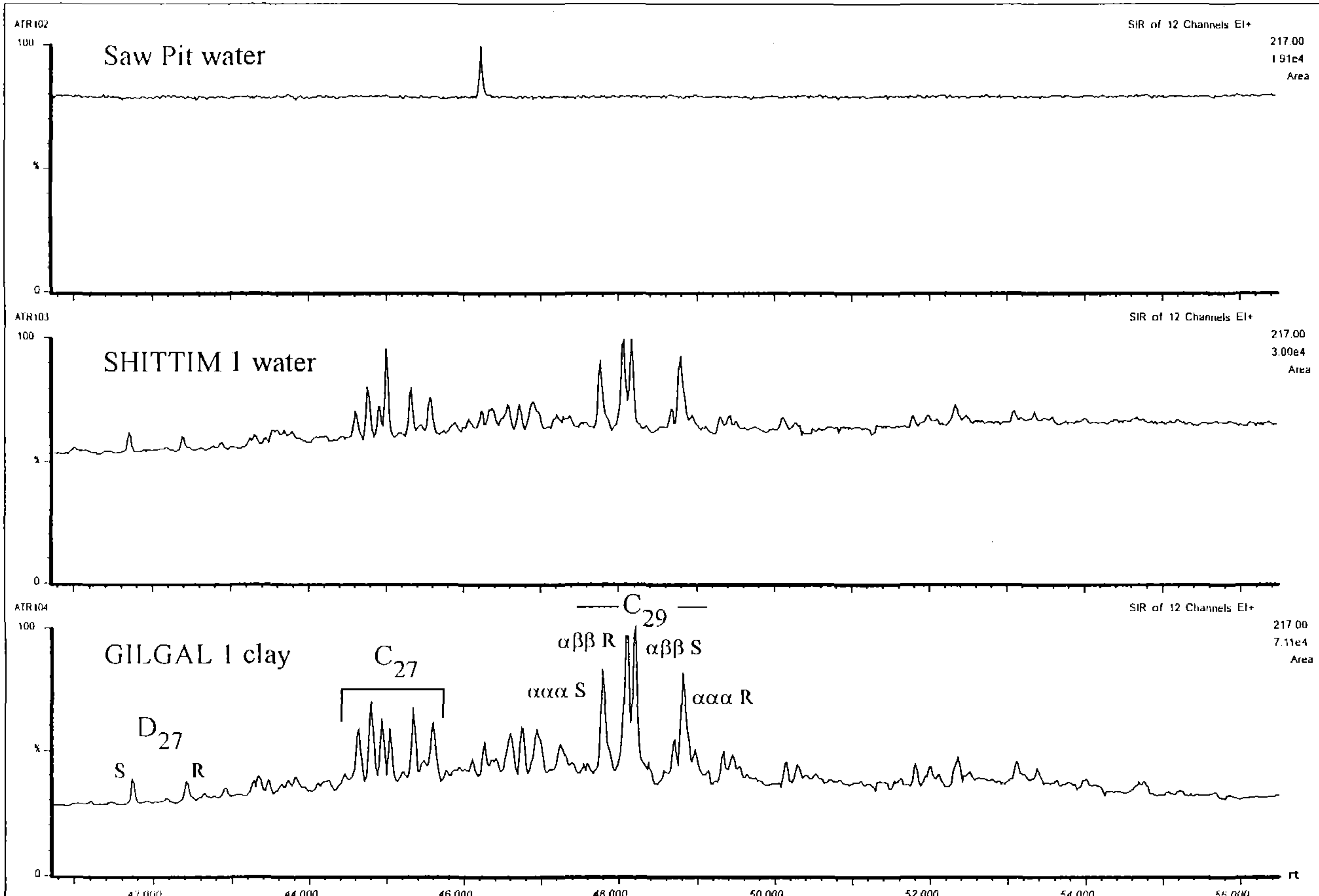


Figure 3: m/z 217 mass fragmentogram showing the sterane profiles for the three samples analysed (numbers refer to carbon number, D = diasteranes, α and β refer to stereochemistry at carbons 5, 14 and 17)

300073

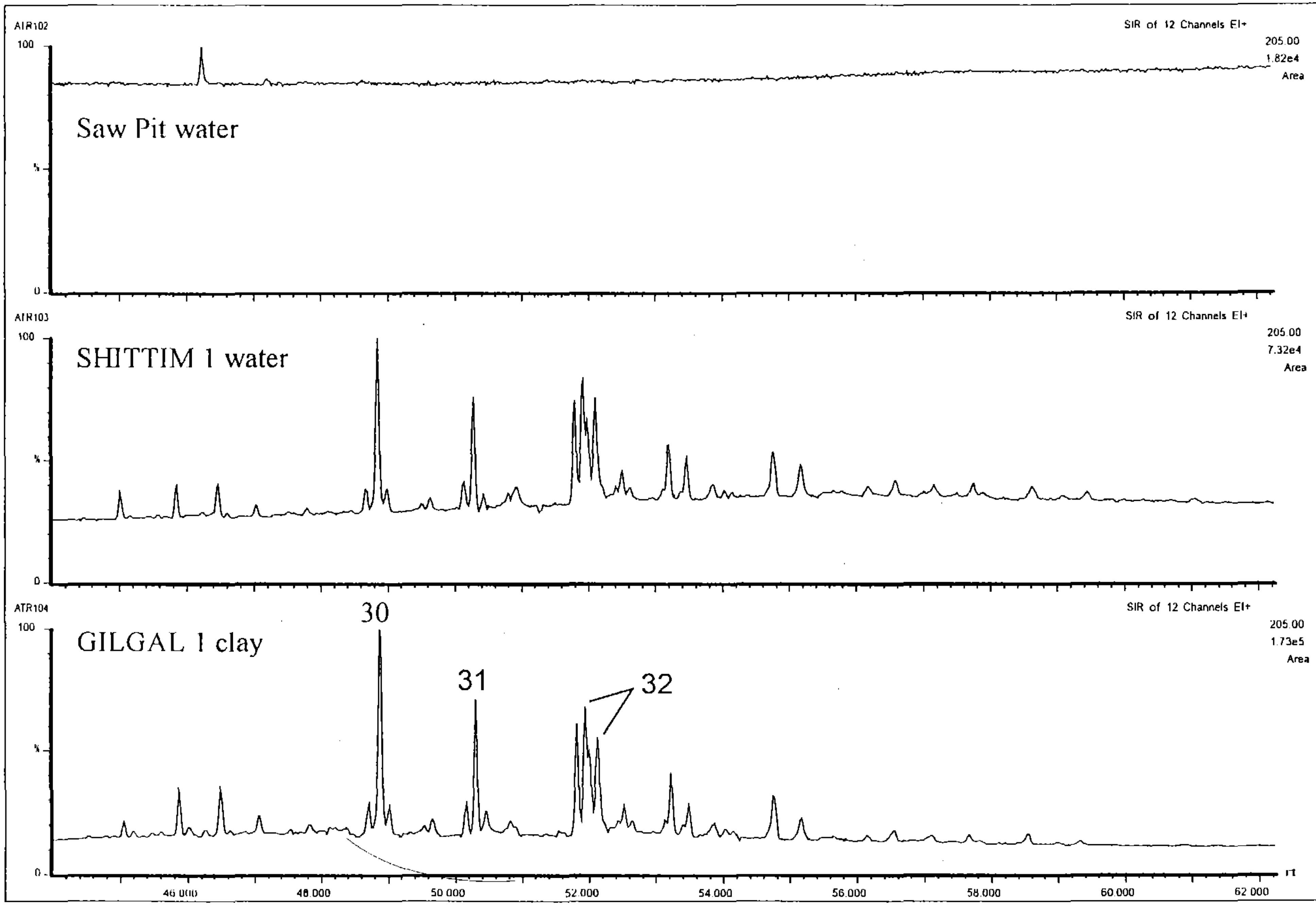


Figure 4: *m/z* 205 mass fragmentogram showing methyl hopanes in the three samples analysed

(numbers refer to carbon number of methyl hopanes)

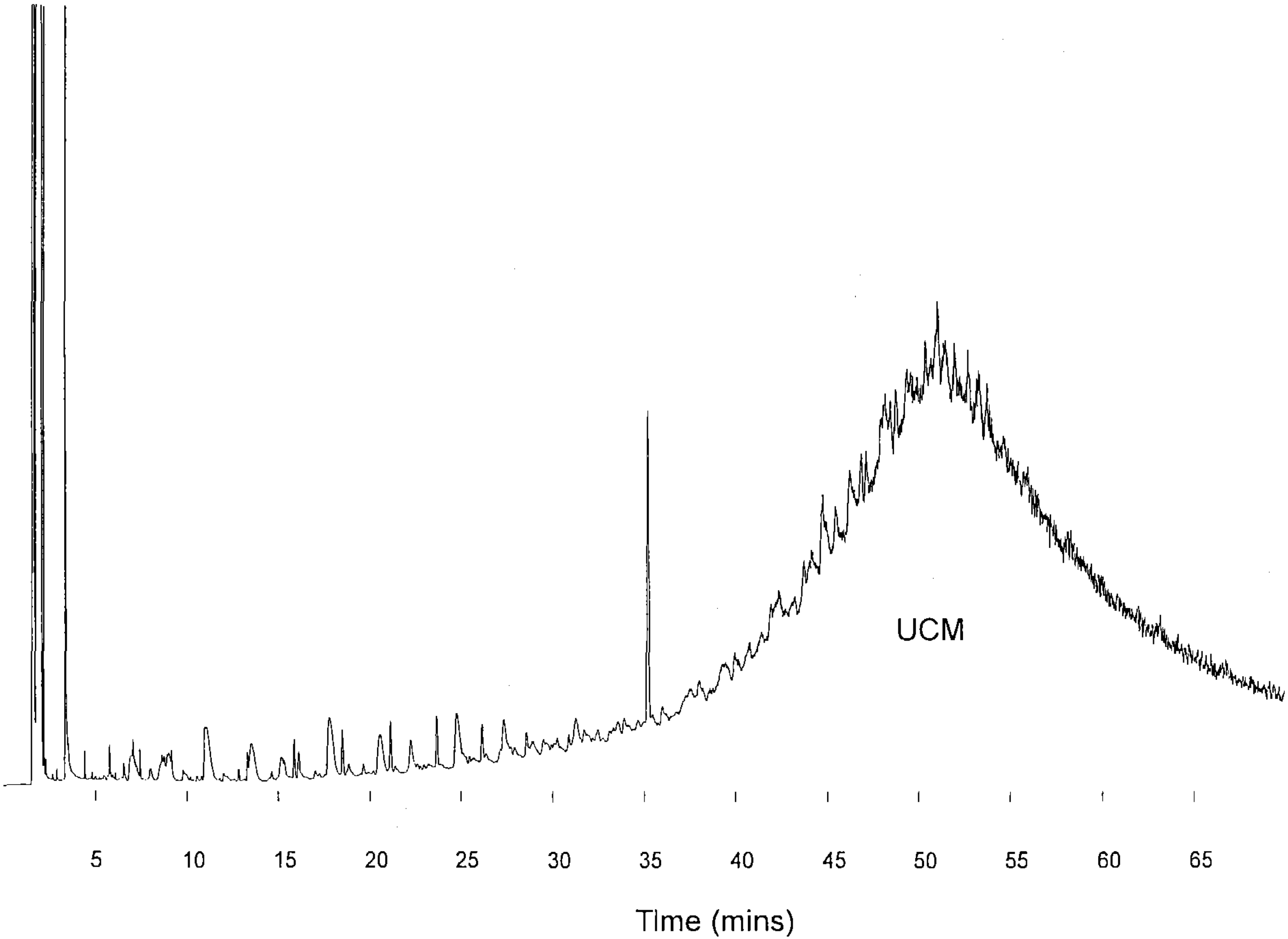


Figure 5: GC chromatogram of the total solvent extract from the GILGAL 1 clay sample

COPY

Appendix (3)

AGSO
AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION

300076

11 November 1994

Director, Exploration
Conga Oil PL
84 Wells Parade
Blackmans Bay TAS 7052

Dear Sir/Madam

Re: Tasmania NGMA Project ("TASGO")

The Australian Geological Survey Organisation and the Tasmanian Department of Minerals and Energy have commenced a series of multi-disciplinary studies under the National Geoscience Mapping Accord (NGMA). We are writing to you to inform you of the project and their progress and to invite you to contact the project leader or staff in the project if you want further information or wish to participate more closely in the work.

This is the first of a new series of communications to explorationists with interests in Tasmania. "TASGO" is one of the new NGMA projects and is being run jointly by AGSO and Mineral Resources Tasmania (MRT). It is designed to understand the major geological events that have influenced the distribution of Tasmania's minerals and petroleum resources.

The project was publicly launched by Tasmania's Premier, Mr Groom, on 21 August 1994. The project plan also received a mention in the August 1994 edition of AGSO's *AusGeo News* and the October/November issue of *PESA News*. It was presented to the Tasmanian Chamber of Mines at its meeting in Launceston on 24 June 1994. A brief update of activities will be given at the Chamber's next meeting in Launceston on 29 November 1994.

The initial phase of the project is dominantly data acquisition (see Attachment 1). Activities include airborne geophysics, land and marine deep reflection seismic surveying, some geochronology and a compilation of relevant geological information. This will be followed by some review work (involving collaboration with Universities and other researchers) and data processing, prior to the substantial interpretive phase.

A synthesis of relevant geological information is underway. A new 1: 500,000-scale strato-tectonic map and time-space plots of Tasmania's tectonic elements, with some relevant neighbouring parts of Gondwanaland for comparison, are being compiled using AGSO's new timescale, to provide a basis for interpreting the new data. Compilations are scheduled to become available from about late December 1994.

Airborne geophysical surveying of inshore regions of Tasmania commenced on 11 October 1994. To date 28,000 line kilometres of magnetic data have been acquired at 800m line spacing, representing nearly one third of the survey (see Attachment 2). The King Island portion will be flown at 400m line spacing and will include gamma-ray spectrometry. The data are being acquired to map the continuations of Tasmania's geological provinces and structures offshore, and to ensure that we position the deep marine seismic reflection lines to cross major structures. Data are expected to become available in the first half of 1995.

Planning for onshore deep reflection seismic surveying in February 1995 is well underway. Our budget will allow about 100 line kilometres to be shot. Tasmania's terrain is far from ideal for the seismic method. Of the traverses considered to be logistically feasible, the following have been selected along existing roads: west Dundas Trough; east Dundas Trough; Mathinna Goldfields lineament; and some experimental soundings in the Tasmania Basin, hopefully through windows in the dolerite.

Planning for the marine reflection seismic survey is also underway. An indicative cruise track is shown on Attachment 3. It is thought to cross many significant geological boundaries and structures. Precise cruise positioning will be fine-tuned when the results of aeromagnetic surveying become available later this year. The ship provides a more cost effective method for imaging the geometry of the major geological structures.

Some new zircon dating will continue in 1995. Priority will be accorded to samples that can date or put timing constraints on tectonic events, or which can improve the accuracy of the geochronological timescale at places where there is good biostratigraphic control.

If you would like to participate in any of our activities, or feel that you could assist in any way, please call us at the numbers indicated below. Further information on the project can be obtained from Tony Yeates at AGSO, telephone (06) 249 9335, or Tony Brown, State Chief Geologist MRT, telephone (002) 33 8365. Specific information on the seismic surveying can be provided by Barry Drummond, telephone (06) 249 9381 or Tim Barton, telephone (06) 249 9625.

With best wishes

Dr Tom S Loutit
Co-Chief,
Minerals Petroleum and
Sedimentary Resources Division,
AGSO

Telephone: (06) 249 9674

Mr Mike Ayre
Director of Mines
Mineral Resources Tasmania

Telephone: (002) 33 8333

ATTACHMENT 1

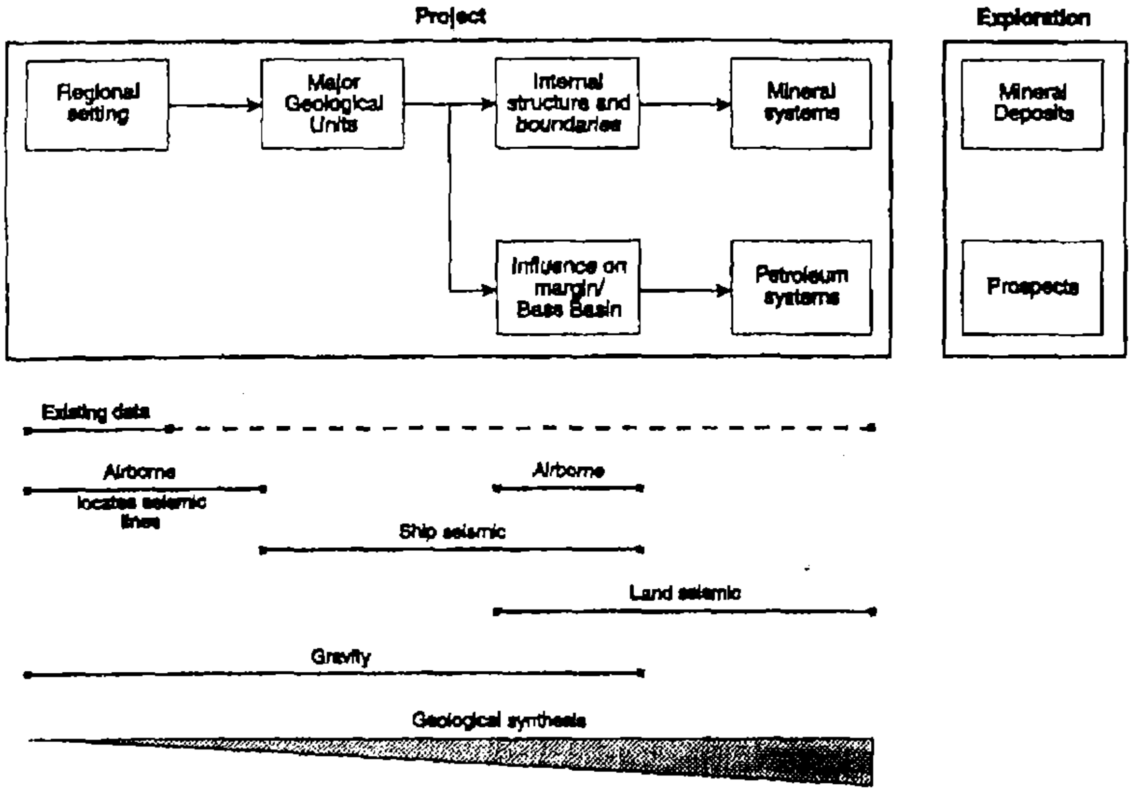


Fig. 1: Project Strategy

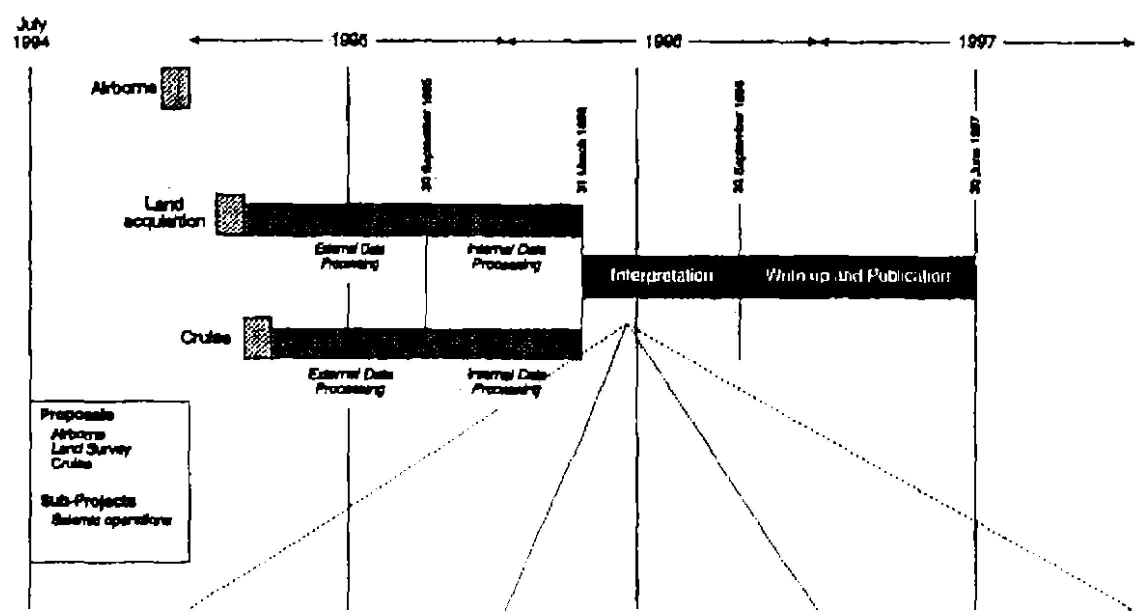
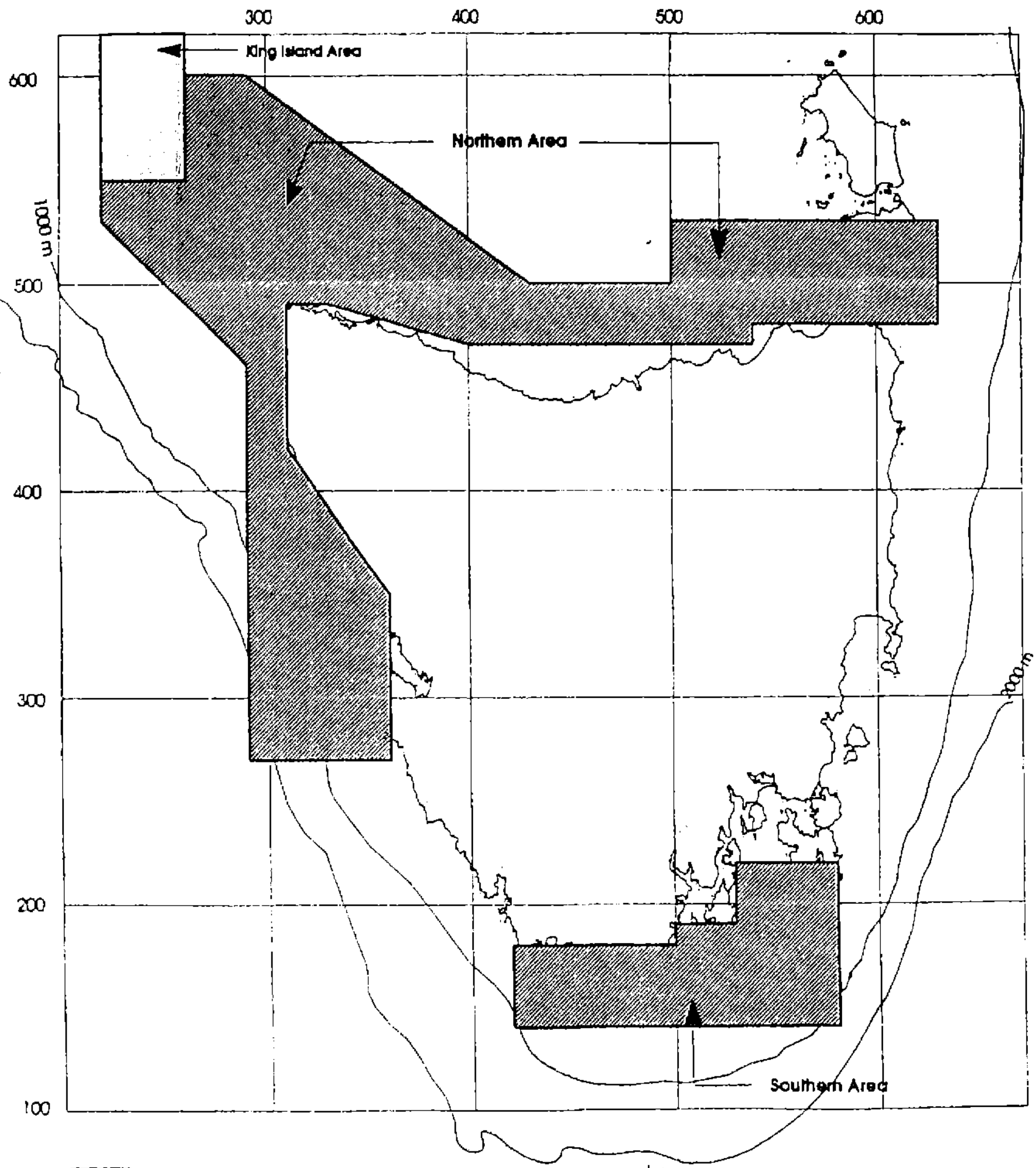


Fig. 2: Project Timetable

ATTACHMENT 2

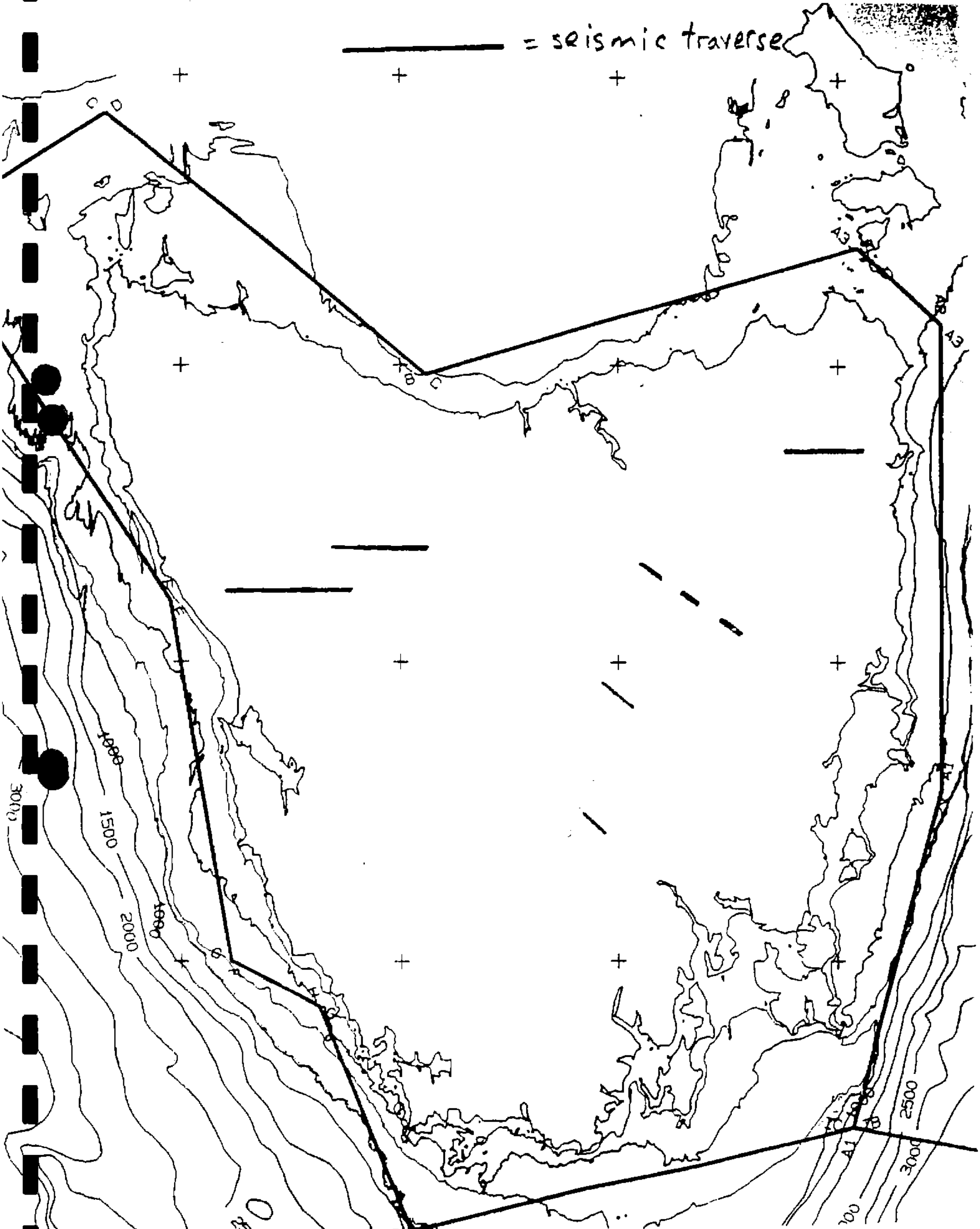
Figure 1 Areas to be covered by geophysical mapping program



800m Line Spacing *aeromagnetics*

400m Line Spacing *aeromagnetics and γ ray spectrometry (King Island)*

ATTACHMENT 3



AUS•GEO *news*

'Geoscience for Australia's Future'

Number 25 ISSN 1035–9338 December 1994

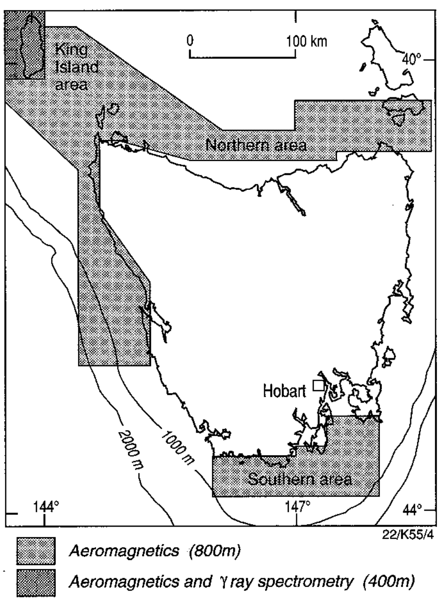
New collaborative national projects off to a flying start

'TASGO'

The initial phase of 'TASGO', the new National Geoscience Mapping Accord joint project between AGSO and Mineral Resources Tasmania (see *AUS.GEO News 23*, for August 1994, p. 3), got under way on 1 October, when a contract high-resolution aeromagnetic survey of 70 000 kilometres over Tasmania and King Island began. The aircraft is flying at an altitude of 130 metres (to minimise the noise of waves from the sea) along east–west lines 800 metres apart, but 400 metres apart over King Island, where gamma-ray spectrometry is being recorded too. The survey is expected to finish in early December.

The recorded data will help to define coastal Tasmania's major structures and tectonic-element boundaries, which in turn will facilitate the optimal positioning of traverses for a deep-marine seismic reflection survey aboard RV *Rig Seismic* in March 1995. The acquisition of 100 kilometres of land seismic data in February 1995 will complement the marine seismic work.

'TASGO' aims to resolve how Tasmania's various tectonic components fit together, and how its minerals and petroleum systems fit into this framework.



'TASGO' airborne survey area.

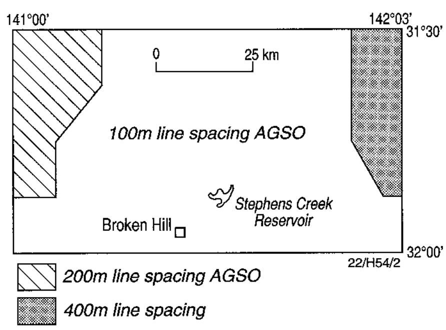
AGSO's Tony Yeates (tel. (06)2499335, fax (06)2499983) and MRT's Tony Brown (tel. (002)338365, fax (002)442117) can provide more information about 'TASGO'.

The Broken Hill Exploration Initiative

AGSO's Aero-Commander geophysical survey aircraft (VH–BGE) commenced a high-resolution survey over the Broken Hill area on 1 October. Flying only 60 metres above the land surface along east–west lines, mostly 100 metres apart, the aircraft will acquire 50 000 kilometres of magnetic and gamma-ray spectrometric data for integrating with other geological and remote-sensing data in a detailed multidisciplinary study of the area — the Broken Hill Exploration Initiative (BHEI; see *AUS.GEO News 23*, for August 1994, p. 4). An early December completion of the survey is expected.

The airborne survey is the largest one of this detail ever undertaken in Australia. Early returns of data are of high quality. The data will provide an outstanding data set and a basis for other detailed geological and geophysical surveys planned for 1995 and beyond.

In September, the Commonwealth Minister for Resources, David Beddall, and his New South Wales and South Australian counterparts, Ian Causley and Dale Baker, together pledged $15 million dollars over 5 years for the BHEI, which AGSO will carry out jointly with the New South Wales Department of Mineral Resources and the South Australian Department of Mines & Energy. The BHEI's objective is to promote mineral exploration and further discovery in the Broken Hill mineral province.



BHEI airborne survey area.

AUS.GEO International 1

The first of a series featuring AGSO's international projects

***AUS.GEO International 1* — the inaugural number of a newsletter focusing on AGSO's contributions to diverse international commitments — is incorporated in this number of *AUS.GEO News*.**

AGSO's support — through its International Program (see *AUS.GEO International 1*, front page) — of Australia's foreign-policy, trade, and international development-assistance objectives has provided it with opportunities to participate in joint projects with geoscientific agencies in many countries.

AGSO's International Program is in addition to its regional geoscientific surveys in Australia, and builds upon the developing skills of its staff and its investment in laboratories and other supporting facilities with state-of-the-art equipment. The complementary nature of its national and international programs enables AGSO to maintain its leadership as the principal Commonwealth Government geoscientific agency. As a result, its capabilities have been greatly enhanced: AGSO is now a world leader in geoscientific mapping and information-systems development.

Today AGSO is engaged in collaborative geoscientific projects in countries in the Pacific, southeast and central Asia, the Middle East, and South America. These projects cover a wide range of objectives and funding arrangements, but share a common theme: the research can be undertaken only by a geological survey organisation equipped with modern facilities and the expertise to use the technology to maximum effect.

AUS.GEO International is a twice-yearly newsletter promoting AGSO's involvement in these overseas projects. Scheduled for issue — free of charge — each June and December, it will be packaged as both a separate newsletter and as a supplement to *AUS.GEO News*. For regular *AUS.GEO News* readers, *AUS.GEO International* will add a new dimension to the customary announcements about outcomes, outputs, and initiatives of AGSO's Australian research and investigations. We hope you enjoy the new addition!

AGSO

Australian Geological Survey Organisation

a research organisation of the Department of Primary Industries & Energy

AGSO participates in the Department of Industry, Science & Technology's Registered Research Agency Program (reg. no. 0167)

'Ocean outlook' Congress

Focusing on EEZ and beyond

AGSO, CSIRO's Division of Fisheries & Oceanography, and the Australian Institute of Marine Science cosponsored 'Ocean outlook', a two-day congress held in Canberra in mid-November to identify research priorities for developing, managing, and protecting Australia's new marine zones, and to contribute to government policy-making. The new marine zones constitute Australia's 200-nautical-mile Exclusive Economic Zone (AEEZ) and remote areas of seabed beyond this that form part of Australia's 'legal' continental shelf.

The 1982 UN Convention on the Law of the Sea (LOSC) came into force on 16 November 1994. Management of the AEEZ and continental shelf carries important international responsibilities, and presents one of the great national opportunities of the future.

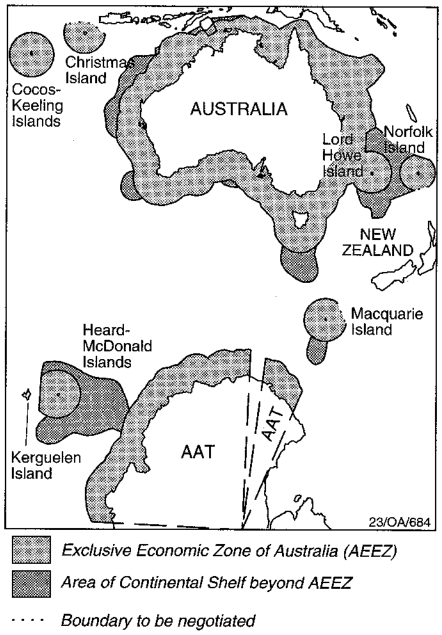
Australia now has a greater area of ocean than of land under its jurisdiction. According to Article 76 of LOSC, the Australian continental shelf (including the EEZ around the Australian Antarctic Territory, AAT) is about 14.8 million square kilometres, nearly twice the size of the continent and one of the world's biggest.

Eight areas of the continental shelf totalling about 3.7 million square kilometres extend beyond the AEEZ. However, Australia must be able to support its claim to these areas by collecting and interpreting bathymetric and seismic data for them, and presenting these data within the next 10 years to the soon-to-be-established UN Commission on the Limits of the Continental Shelf.

AGSO has already surveyed some of these remote areas aboard RV *Rig Seismic* as part of its Continental Margins Program (CMP). Even so, much remains to be done: insufficient data are available for five of the eight areas beyond the AEEZ, and at least eight one-month cruises (excluding the AAT) aboard *Rig Seismic* would be needed to acquire the appropriate data.

The Federal Government recently acknowledged the urgency of this task in a Cabinet decision concerning the future funding of AGSO's CMP, and has given top priority to the collection of data necessary for Australia to meet its commitments under the LOSC.

For more information, contact Phil Symonds (tel. (06)2499490, fax (06)2499986).



Marine jurisdictional zones of Australia.

U–Pb zircon ages, northern Drummond Basin

AGSO has released the results of a geochronological study of nine volcanic and plutonic rock samples from the Burdekin Falls area, northern Drummond Basin, northeast Queensland.

This study has shown that late Palaeozoic magmatism within the Bulgonunna Volcanic Group was active for about 15 million years during the Carboniferous–Permian transition. The earliest identified activity started at about 304.7 million years (Locharwood Rhyolite and correlated felsic volcanics). Later volcanism included the eruption of dacitic andesite and ignimbrite (about 297.4 million years) and further rhyolite (Arundel Rhyolite; about 293.5 million years). The emplacement of coeval potassic and sodic granites about 289.4 million years ago marked the end of the magmatism; the similar age and initial $^{87}Sr/^{86}Sr$ (0.7045) indicate that these granites are comagmatic.

AGSO Record 1994/34 (Mineral Provinces 38), 'U–Pb zircon ion-microprobe ages from the northern Drummond Basin, northeastern Queensland' by Lance Black, presents the analytical data and accounts of the significance of the ages and of the regional implications.

Record 1994/34 costs $15 + postage and handling charges of $5 (in Australia) or $15 (overseas).

'Quaternary climate in Australia', 2nd edition

AGSO has released a second edition of its annotated bibliography, 'Quaternary climate in Australia'. Published in two volumes as *AGSO Record 1994/52*, the second edition of this bibliography contains 2000 references — 500 more than the first edition, which was issued as *AGSO Record 1991/104* (see *AUS.GEO News 8*, for February 1992, back page). Volume 1 lists the references alphabetically by authors' (or senior authors') names. Volume 2 lists the references as thematic compilations: palaeoclimate, for which the States constitute separate subthemes; climate modelling; coastal processes; dune-fields; glaciation; humans and palaeoenvironment; limnology; palaeontology; palynology; and sea level. The references in both volumes are annotated with an extensive selection of index terms.

Record 1994/52 is available as follows:

- two hard-copy documents comprising over 400 pages, and costing $60 + postage and handling charges of $15 (in Australia) or $45 (overseas); and
- digital files available on floppy disk in a range of custom-specified formats for $30 + postage and handling charges of $5 (in Australia) or $15 (overseas).

Something old, something new ... in AGSO fossils

Two new catalogues of fossils in the Commonwealth Palaeontological Collection (CPC) have just appeared. But what is this collection?

The CPC is a national collection of almost exclusively Australasian fossils which have been illustrated or otherwise referred to in scientific publications. It includes the type specimens of many species and genera. Originating with the 1927 appointment of a Commonwealth Palaeontologist, the CPC is currently administered by AGSO. Because it contains type specimens, there is an international responsibility (under articles of the International Codes of Zoological and Botanical Nomenclature) to make the collection accessible for scientific study. Catalogues help meet that responsibility: they bring together and make known internationally what would otherwise be widely scattered and commonly obscure information on the specimens in the collection.

The CPC catalogues are produced from AGSO's Oracle database PALEO. The first three appeared in the *Report* series of the Bureau of Mineral Resources, Geology and Geophysics (AGSO's predecessor), and covered the Brachiopoda (*Report 298*), Bryozoa (*Report 305*), and Archaeocyatha, Porifera and Coelenterata (combined in *Report 307*). The two new catalogues are published within a *CPC Catalogues* subseries of the *AGSO Record* series:

- *Record 1994/32 (CPC Catalogue 4)* — Vertebrata; and
- *Record 1994/35 (CPC Catalogue 5)* — Conodonta.

Each catalogue systematically provides taxonomic, bibliographic, locality, horizon, and age information for the specimens. In the Vertebrata catalogue, specimens are organised within a taxonomic framework; for the Conodonta, however, such a framework is as yet uncertain, so the genera and species are listed alphabetically. Comprehensive indices supplement the texts.

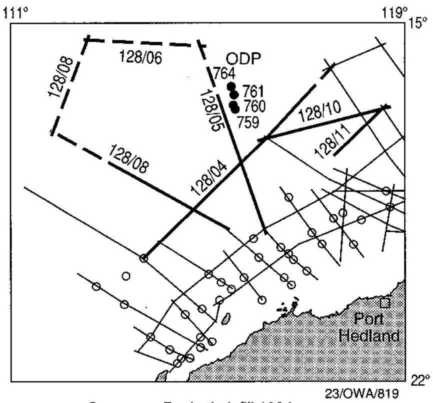
The size of the CPC reflects a strong research effort to document fossil faunas and floras from all ages and areas which have been the subject of geological investigations by AGSO. The CPC is thus an essential database for biochronological dating and environmental studies of sedimentary rocks, and has wide application in geological mapping and subsurface investigations associated with all aspects of land use, including petroleum and mineral exploration.

The Vertebrata catalogue costs $20 + postage and handling charges of $5 (in Australia) or $15 (overseas), and the Conodonta catalogue costs $30 + postage and handling charges of $10 (in Australia) or $25 (overseas).

North West Shelf

Marine non-exclusive deep-seismic–well-tie-data releases

In association with PGS Nopec Pty Ltd, AGSO is releasing data from seismic lines recorded in the Carnarvon Basin in June this year during AGSO survey 128 (CBTIX-94), and in the Browse Basin in June and August this year during AGSO survey 128 and 130 (BBTI-94).

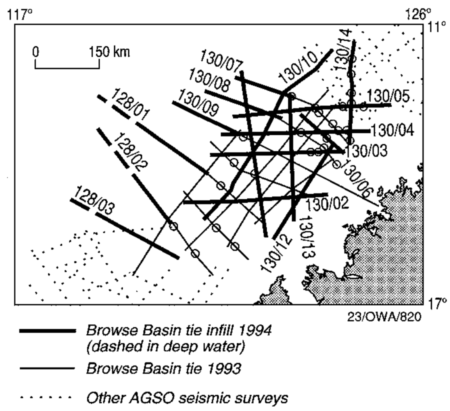


Seismic lines recorded in AGSO's Carnarvon Basin survey (128) area.

Extending the coverage of previous AGSO surveys in the **Carnarvon Basin**, part of survey 128 focussed on the northern half of the Exmouth Plateau, adjacent ocean basins, and the outer Beagle Sub-basin. It acquired 1300 kilometres of seismic data over frontier petroleum prospective areas, and, in very deep water, 1100 kilometres of seimic data that are expected both to provide lateral control from the Ocean Drilling Program wells on the northern edge of the Exmouth Plateau and to image the link between the margin and the oceanic basins.

The remaining part of survey 128, and survey 130, acquired 4610 kilometres of seismic data in the **Browse Basin**. These data complement those of a previous AGSO survey, 119 in 1993, and were recorded to infill gaps in the regional deep-seismic grid; to tie wells not already tied to the grid; and to provide better control on the trends of some major deep, particularly north-trending, structural features interpreted from the previous data set.

These two surveys constituted an integral part of AGSO's program of deep-seismic-data acquisition on the North West Shelf. The objectives of this program are to assess the regional structural framework and interrelationships of the basin elements; and resolve the basin-forming structures — their nature, evolution, and role in controlling the locations of hydrocarbon fields and plays.



Seismic lines in AGSO's Browse Basin surveys (128 and 130) area.

The CBTIX–94 data were released in November, and the BBTI–94 data are expected to be available in January 1995.

For companies making a commitment to purchase the data before 15 December, prices start at $55 per kilometre for orders of 1300+ kilometres of data from survey CBTIX–94 or of 3000+ kilometres from survey BBTI–94; and, thereafter, $77 per kilometre for the same orders. Reproduction, handling, and postal charges are extra. Release brochures and details of pricing structures can be obtained from Chris Johnston at AGSO on tel. (06)2499353 or fax (06)2499981; or Jan Ostby on tel. (09)3215126 or fax (09)3215197.

National Landcare Program geophysical data releases

Wanilla (SA), Serpentine (Vic.), and Cressey (Tas.) regions

Under the National Landcare Program, the Commonwealth Department of Primary Industries & Energy funded airborne geophysical surveys to measure electrical conductivity and acquire magnetic data in the Wanilla, Serpentine, and Cressey regions. The data were collected along east–west lines 200 metres apart with north–south tie-lines 2 kilometres apart. They will be used to contribute to salinity studies.

The products, available in ER Mapper format, are:

Wanilla region

- three conductance grids;
- a magnetic grid;
- a grid of the first vertical derivative of the magnetic data;
- three grids of the radiometric count rates measured — one each for the potassium, uranium, and thorium channels;
- a grid produced by digitising the aerial photographs of the area; and
- a grid of the terrain produced from the global-positioning-system (GPS) and radar-altimeter data.

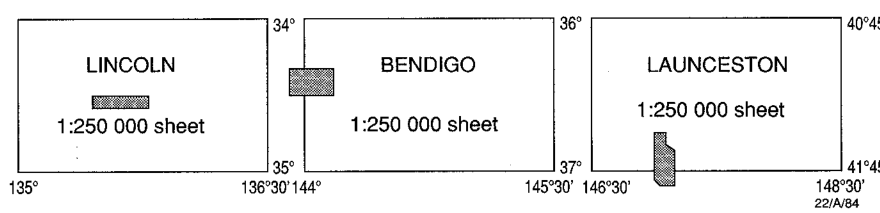
Serpentine region

- two conductance grids;
- a grid of the magnetic data; and
- two grids of the terrain produced from the (GPS) and radar-altimeter data.

Cressey region

- five conductance grids;
- a grid of the magnetic data; and
- a grid of the terrain produced from the (GPS) and radar-altimeter data.

The data for each region, supplied on magnetic tape, may be purchased through the AGSO Sales Centre for $500.



The Wanilla (SA), Serpentine (Vic.), and Cressey (Tas.) regions survey areas.

Mapping the regolith of a low-relief semi-arid region from gamma-ray spectrometric and Landsat Multispectral Scanner imagery

AGSO high-resolution airborne gamma-ray spectrometric data for the Highland Rocks region (NT; between latitudes 20°42′ and 22°01′S, and longitudes 129°14′ and 131°21′E) have proved invaluable for differentiating regolith types. Unlike Landsat Multispectral Scanner (MSS) data, these data are insensitive to variations in vegetation cover, and are therefore unaffected by fireburns.

A simple red–green–blue colour composite of the potassium, thorium, and uranium bands, displayed with a linear stretch, provides the best discrimination of regolith types: it effectively distinguishes between laterite, calcrete, bedrock, and transported sediments. Further, the ability of the gamma-ray signal to penetrate 30–40 cm below the surface facilitates the identification of extensive areas of the subsurface beneath a thin veneer of sediments. Palaeodrainage lines defined by calcrete outcrops are also prominent on the image, and so too is an extensive plume of granite-derived sediment owing to its high potassium content.

The imagery has aided the identification of 20 regolith types, which are presented on a 1:500 000 colour map of the Highland Rocks region. The map, and a supporting text, which documents the processing and integration techniques applied to the imagery and the subsequent interpretation, are packaged as *AGSO Record 1994/38.*

AGSO Record 1994/38, 'Preliminary regolith mapping of the Highland Rocks region using Landsat MSS and high resolution gamma-ray spectrometric imagery' by David Maidment, costs $25 + postage and handling charges of $5 (in Australia) or $15 (overseas).

Geophysical maps and data for the Cape York Peninsula Land Use Strategy

Digital-elevation-model data and contour and pixel-image maps

AGSO has released digital-elevation-model (DEM) products for three 1:250 000 Sheet areas in north Queensland, as follows:

- **Hann River** (SD54–16) — contour and colour pixel-image maps, and data;
- **Ebagoola** (SD54–12) — contour and colour pixel-image maps, and data; and
- **Cape Weymouth/Weipa/Jardine River** (south)/**Orford Bay** (south; SD54–4 and 3, and SC54–15 and 16, bounded by latitudes 11.55°–13.00°S and longitudes 141.3°–143.5°E) — contour map, and data.

These products constitute an AGSO contribution to the Cape York Peninsula Land Use Strategy, a joint initiative of the Commonwealth and Queensland Governments.

AGSO generated the DEM data from airborne geophysical surveys[1] that it flew along east–west flight lines 400 metres apart 100 metres above the ground (for Hann River in 1991, and Ebagoola in 1990), and 1500 metres apart 150 metres above the ground (for Cape Weymouth etc. in 1986).

Data for the Hann River DEM

For the Hann River survey, the navigation data were provided by a satellite global positioning system (GPS), which recorded both positional (latitude–longitude) information relative to the WGS84 reference ellipsoid, and the height of the aircraft above the ellipsoid. The GPS data were sampled every 700 metres (10 seconds), and recorded in separate receivers (one in the aircraft, the other at a fixed location). An Ashtech proprietary program ('Ranger') was used to post-process the aircraft data, for which the fixed-location data provided the reference data set. The post-processing increased the final accuracy of the horizontal positioning data by a factor of at least 10.

The ground elevation was derived by subtracting the height of the aircraft above the ground — recorded once every second on the aircraft's radar altimeter — from the height of the aircraft above the ellipsoid.

The raw elevation data have values calculated every 70 metres (1 second), and refer to height above the ellipsoid — a horizontal datum. A vertical datum is usually chosen to be the geoid, which is the equipotential surface of the gravity field that best approximates mean sea level. Heights referred to the geoid are the heights usually plotted on maps. The height of the geoid above the ellipsoid is the geoid separation, or N value.

The Australian Surveying & Land Information Group supplied the set of N values, which was subtracted from the raw elevation data to provide heights above mean sea level.

The last correction related to the separation between the GPS antenna (on the roof of the aircraft) and the radar-altimeter antenna (on the belly of the aircraft) — a distance of 1.675 metres, which was also subtracted from the raw elevation data.

A minimum-curvature technique was applied to grid the processed line data to a cell size of 80 metres (3.0″) for presenting the ground elevation as a contour map.

Data for the Ebagoola DEM

For the Ebagoola survey, a Syledis electronic navigation system provided the navigation data; and the aircraft's radar altimeter and barometer recorded, respectively, the ground clearance and height above sea level. The ground elevation was calculated every 70 metres (1 second) as the difference between the heights of the aircraft above sea level and above the ground.

A minimum-curvature technique was applied to grid the processed line data to a cell size of 80 metres (3.0″) for presenting the ground elevation as a contour map. The grid was warped to make it consistent with that derived from the GPS data acquired on the northern edge of the adjacent Hann River Sheet area. Analysis of the warped grid showed that coastal elevations were within 10 metres of sea level. This surface was then used to correct the position-located data.

Data for the Cape Weymouth etc. DEM

Doppler navigation and aerial photographs provided the navigation data for the aircraft flying the Cape Weymouth survey. The aircraft's ground clearance (recorded on a radar altimeter) and altitude (barometer) were sampled every 1 second. Raw heights relative to sea level were calculated according to the formula:

$$\text{Height} = 18\,400 \times [\log(1000) - \log(\text{pressure})] - \text{radar altimeter}$$

The heights were then warped to conform with the coastline, and to a surface generated from smoothed heights recorded at gravity stations in the survey area.

A minimum-curvature technique was applied to grid the processed line data to a cell size of 400 metres (15.0′) for presenting the ground elevation as a contour map.

Maps and data costs; further information

Digital-elevation-model contour maps for the Hann River, Ebagoola, and Cape Weymouth/ Weipa/Jardine River (south)/Orford Bay (south) 1:250 000 Sheet areas each cost $40 for a dyeline, and $120 for a transparency. Digital point-located and gridded elevation data, which are available on magnetic tape, cost $1000 for each of the three models.

The digital-elevation-model colour pixel-image maps of the Hann River and Ebagoola 1:250 000 Sheet areas each cost $250 + $16.65 sales tax.

More information about the generation of the DEMs for CYPLUS can be obtained from Mario Bacchin or Ian Hone on tel. (06) 2499111 or fax (06)2499986.

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[1]Previous issues of *AUS.GEO News* carried announcements about releases of the resulting packages of geophysical maps and data for the Hann River (total magnetic intensity [TMI] and gamma-ray spectrometric contours and profiles, and digital point-located and gridded magnetic and gamma-ray spectrometric data; see *AUS.GEO News 12*, for October 1992, p. 6; and *14*, for February 1993, p. 6) and Ebagoola Sheet areas (TMI and gamma-ray spectrometric contours and profiles, TMI colour and grey-scale pixel images, and digital point-located magnetic and gamma-ray spectrometric data; see *AUS.GEO News 7*, for January 1993, p. 6; *10*, for June 1992, p. 6; and *12*, for October 1992, p. 6).

Cape York Peninsula 1:1 000 000 Bouguer anomaly map

AGSO has compiled a 1:1 000 000 Bouguer anomaly map of Cape York Peninsula between latitudes 10 and 16°S and longitudes 141 and 145°30′E; the map projection is Lambert Conformal Conic. The contours are based on a gridded data set of Bouguer anomalies calculated at a density of 2.67 tonnes per cubic metre, and are spaced at intervals of 20 micrometres per second per second. The grid has a mesh size of 1.5 minute of arc (about 2.5 kilometres). Gravity station locations are represented by small squares.

The map may be purchased as a dyeline for $25, or transparency for $75.

Further information is available from Ms Alice Murray on tel. (06)2499264 or fax (06)2499986.

Wallace H. Campbell: expert on geomagnetism visits AGSO for one year

The rumour that Dr Wallace H. Campbell's research in geomagnetism predates the formation of the Earth's liquid core is not true. It is true, however, that his work during the past 40 years has made a major contribution to our understanding of the Earth's magnetic field. He has been innovative in the study of global patterns of the geomagnetic-field variations during quiet solar times; developed new and better methods of magnetically determining conductivity profiles of the Earth to depths of 600 kilometres; improved our knowledge of the effects of electrical currents induced in oil pipelines by geomagnetic storms; and significantly advanced our understanding of high-frequency geomagnetic disturbances (micropulsations).

Dr Campbell now works for the US Geological Survey, which he joined in 1973. He has published more than 100 scientific papers, authored several books, and recently finished writing a new monograph entitled 'Maglight — an introduction to geomagnetism'.

For most of the forthcoming year, Dr Campbell will be working in AGSO's Geomagnetism Section, where he will be modelling the Australian solar quiet-day variations and deep-Earth electrical conductivity. He is also presenting at AGSO an introductory course of 20 lectures on geomagnetism; he will present a shorter course in Sydney at the Ionospheric Prediction Service, and is planning to present another course in Perth on external geomagnetic-field effects for aeromagnetic exploration personnel. During February and March, he will visit Flinders University of South Australia.

Dr Campbell's telephone number at AGSO is (06)2499749, so call him if you wish to make contact.

AGSO Library and Sales Centre

Christmas–New Year closure

The AGSO Library, including the Map Library at NRMA House, and the Sales Centre will be closed for the Christmas–New Year season from 4 p.m. on Friday 23 December until 9.00 a.m. on Tuesday 3 January. We hope this will not inconvenience any of our patrons and customers.

Stratigraphic-names register moves house and invites comment on planned improvements

On 11 August 1994 Cathy Brown and the Central Register of Australian Stratigraphic Names moved both structurally and physically within AGSO. The Central Register is now part of the National Geoscience Information System (NGIS) Program in AGSO's Division of Information Services. It has relocated to room 77, ground floor, Anzac Park East building, Parkes, ACT.

The main functions of the Central Register were outlined in *AUS.GEO News 11*, for August 1992, page 6. Information from the Central Register is available to all geoscientists working on Australian projects.

Improvements planned over the next few months include:

- a redesign of the stratigraphic part of the Central Register's GEODX database;
- adding a code for all the reserved names (the published names already have a code), and combining the *reserved names* & *published names* tables; this will allow simpler links with GIS systems;
- coding of superseded and (more) misspelt names (with help from the Stratigraphic Names Committee of the Geological Society of Australia); this will improve the speed and quality of information provided to customers; and
- developing new menus and views of the database to facilitate direct access by customers.

Some of these proposals have come from discussions with staff of various State geological surveys (particularly NSW, Qld, SA, and WA). We have also had additional input from Colin Gatehouse, Convener, and from several other members of the Stratigraphic Names Committee of the Geological Society of Australia.

Please contact Cathy Brown for further information on the proposed changes (tel. (06)2499535, fax (06)2499977). Your comments and suggestions are welcome. Written enquiries should be sent to AGSO's postal address (see foot-box, back page).

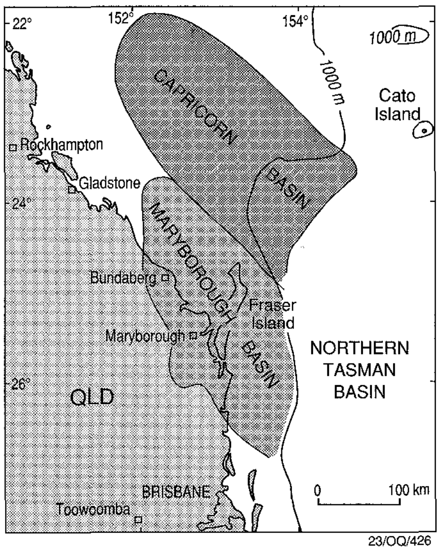
AGSO Journal 15(3)

AGSO recently released the latest number of the *AGSO Journal of Australian Geology & Geophysics* — volume 15, number 3 — whose table of contents is as follows:

This issue of the *AGSO Journal* costs $40 + postage and handling charges of $5 (in Australia) or $15 (overseas). The *AGSO Journal* is available by subscription at a cost of $80 to individuals or $120 to corporations for four quarterly numbers.

Maryborough, Capricorn, and northern Tasman Basins

Documentation of results of an integrated AGSO investigation



Basin locations, offshore southern Queensland.

AGSO has released the results of the first basin-wide structural and seismic-stratigraphic analyses of the Maryborough and Capricorn Basins: *AGSO Record 1994/1* — 'Geology and geophysics of the offshore Maryborough, Capricorn and northern Tasman Basins: results of AGSO survey 91' by Peter Hill. Comprising 71 pages of text, tables, and text-figures, and 34 large-format enclosures, this report documents the results of an interpretation of multichannel seismic reflection, sonobuoy refraction, wide-angle reflection, magnetic-profile, gravity, and bathymetric data acquired by AGSO in 1989, and integrated with data acquired from previous government and company surveys.

Record 1994/1 costs $200 + postage and handling charges of $25 (in Australia) or $60 (overseas).

Genera file of fossil spores and pollen

From the moment it appeared, AGSO's Dennis Burger has been a regular user of the genera file of fossil spores and pollen (GFFSP) of Jansonius & Hills (1976). To find his way around in the GFFSP, he has built up a key for spores and pollen grains, which AGSO has now issued as *Record 1994/46*: 'Guide to genera file of fossil spores and pollen of Jansonius & Hills (1976)'.

The key assembles the spores and pollen grains into turma, subturma, infraturma, etc. Within each of these categories, genera are listed alphabetically with GFFSP number, age of genotype, and — where relevant — symbols showing type of synonymy, change in taxonomic rank, and type of fossil (megaspore/-pollen, tetrad).

AGSO Record 1994/46 is designed to help subscribers to the GFFSP. It contains about 3900 entries (including GFFSP supplement 11 of 1992). It costs $35 + postage and handling charges of $5 (in Australia) or $15 (overseas).

For further information, contact Dr Dennis Burger (tel. (06)2499413 or fax (06)2499983).

RV *Rig Seismic* provisional schedule

Otway Basin deep-seismic survey (part 1)

- 26 November to 22 December 1994

Otway Basin deep-seismic survey (part 2)

- 3–26 January 1995

Tasmania offshore geological survey

- late January to late February 1995

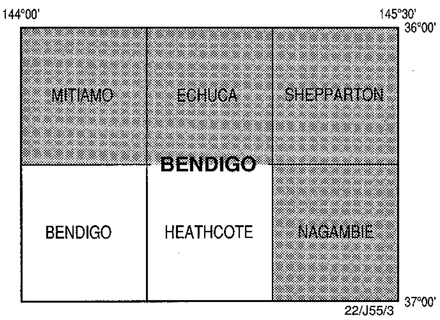
Tasmania offshore seismic survey

- March 1995

Airborne geophysical maps and data for National Geoscience Mapping Accord projects

Profile, flight-line, and digital-elevation-model maps and data for the Bendigo 1:250 000 Sheet area

AGSO has started releasing the first of the maps issuing from the Bendigo (Vic. and NSW) airborne geophysical survey, which it flew early this year as a contribution to the Lachlan–Kanmantoo Fold Belts NGMA project (see *AUS.GEO News 20*, for February 1994, p. 3). The data from which these maps were compiled were acquired along east–west flight lines spaced 400 metres apart (but 200 metres apart in part of the Nagambie 1:100 000 Sheet area) 100 metres above the ground.



1:100 000 Sheet areas (screened) for which profile and flight-line maps are available in the Bendigo 1:250 000 Sheet area

Profile and flight-line maps

The following, newly released maps — part of the Bendigo 1:250 000 Sheet area (SSJ55–1) — are available as dyeline or transparent (sepia or double clear) copies:

1:100 000 Sheet area	*Map types (see key below)* 1	2	3	4	5	6	7
SJ55–1/1 Mitiamo		x		x		x	
SJ55–1/2 Echuca		x		x		x	
SJ55–1/3 Shepparton		x		x		x	
SJ55–1/6 Nagambie		x		x		x	

Elevation map

A contour map of the digital elevation model — produced by combining data from the survey aircraft's GPS with the aircraft's radio-altimeter record, as described for the Hann River DEM (p. 4), except that the GPS height data were sampled every 350 metres (5 seconds) on the Bendigo survey — is available as a dyeline or transparency (sepia or double clear) for the whole of the Bendigo 1:250 000 Sheet area. For more information about the derivation of the Bendigo DEM, contact Ross Franklin on tel. (06)2499272 or fax (06)2499986.

Digital data

Digital-point-located and gridded airborne geophysical (magnetic and gamma-ray spectrometric) data for the four 1:100 000 Sheet areas for which profile and flight-line maps have been released, and digital point-located and gridded elevation data for the whole of the Bendigo 1:250 000 Sheet area, are available on magnetic tape.

Costs

The **profile and flight-line maps** each cost $15 for a dyeline and $45 for a transparency.

The **elevation map** costs $40 for a dyeline, and $120 for a transparency.

The **point-located geophysical data** are available in units of 1:25 000 Sheet areas (7.5′ x 7.5′) as follows (minimum order $600 per 1:250 000 Sheet area):

No. of map sheets	*Cost ($) per Sheet area* 400-m line spacing	200-m
4–15 (each map sheet)	150	300
16–95 (each map sheet)	130	
Full 1:100 000 set (16 x 1:25 000 maps)	2080	
Full Nagambie 1:100 000 set of maps		2210

The **gridded geophysical data** are available in units of 1:100 000 Sheet areas, as follows:

	Cost ($)
1 x TMI grid (3-second)	500
4 x gamma-ray spectrometric grids (3-second)	500
Grids + position-located profile data	2500

The **digital elevation data** cost $1000.

Key to map types

1. Total magnetic intensity contours
2. Total magnetic intensity profiles
3. Total-count gamma-ray spectrometric contours
4. Total-count gamma-ray spectrometric profiles
5. Uranium, thorium, potassium profiles (3 maps)
6. Flight-line system
7. Radio-altimeter profiles

First of the maps and data from AGSO's 1994 East Kimberley airborne survey

AGSO released in September the first batch of products derived from its East Kimberley geophysical survey, which was flown along east–west flight lines 400 metres apart 100 metres above the ground between mid-May and mid-July this year (see *AUS.GEO News 22*, for June 1994, p. 5). All these products — digital-elevation-model contour and pixel-image maps, and digital elevation data — are for the Lissadell 1:250 000 Sheet area (SE52–2, NT), part of the Kimberley–Arunta NGMA.

Maps

The digital elevation model of the Lissadell 1:250 000 Sheet area combines the latest height data with accurate positional information. It was produced by combining data from the survey aircraft's GPS with the aircraft's radio-altimeter record, as described for the Hann River DEM (p. 4), except that the GPS height data were sampled every 350 metres (5 seconds) and the processed line data were gridded to a cell size of 90 metres for the Lissadell model. It is available as a dyeline or transparency (sepia or double clear) contour map, or as a colour pixel-image map.

For more information about the derivation of the DEM, contact Mario Bacchin or Ian Hone on tel. (06)2499111 or fax (06)2499986.

Digital data

Digital-point-located and gridded elevation data for the Lissadell 1:250 000 Sheet area are available on magnetic tape.

Costs

- contour elevation map — **$40** (dyeline), **$120** (transparency);
- colour pixel-image elevation map — **$300 + $20** sales tax; and
- digital elevation data — **$1000.**

Duketon and Edjudina 1:250 000 Sheet areas, Eastern Goldfields

AGSO acquired airborne geophysical data earlier this year in the Edjudina and (in collaboration with the Department of Minerals & Energy, WA) Duketon 1:250 000 Sheet areas, as part of the Eastern Goldfields NGMA, and is now releasing products derived from them. The aircraft surveying both Sheet areas flew along east–west lines 400 metres apart 80 metres (in Duketon) and 100 metres (in Edjudina) above the ground.

Contour and profile maps, and geophysical data

A total-count contour map of the Duketon 1:250 000 Sheet area, now available, complements an earlier release (announced in *AUS.GEO News 23*, for August 1994, p. 6) comprising:

- the TMI contour map for the Duketon 1:250 000 Sheet area;
- TMI contour, TMI profile, and flight-line maps for the six 1:100 000 Sheet areas constituting the Duketon 1:250 000 Sheet area; and
- digital point-located airborne geophysical (magnetic and four-channel gamma-ray spectrometric) data and and grid data for the Duketon 1:250 000 Sheet area.

TMI pixel-image maps

AGSO has compiled, for the Duketon and Edjudina 1:250 000 Sheet areas, colour and grey-scale pixel-image maps of TMI from total-field aeromagnetic data from which the International Geomagnetic Reference Field was removed. Minimum curvature was applied to grid the profile data to a cell size of 3 seconds of arc (about 80 metres in latitude). Processing of the grid data in the spectral domain removed asymmetries introduced by the inclination of the Earth's magnetic field (i.e., they were reduced to the pole). For the colour image, histogram equalisation facilitated the selection of pixel colours from the natural palette (magenta high, blue low), and modulating the colour intensity and saturation enhanced the relief of the TMI gradient. The grey-scale image represents the first vertical derivative of the TMI grid data, to which automatic gain control was applied to normalise the anomaly amplitudes.

For more information about the generation of these pixel-image maps, contact Peter Milligan on tel. (06)2499224 or fax (06)2499986.

Costs

- Duketon 1:250 000 Sheet area total-count contour map — **$100** (dyeline), **$250** (transparency, either sepia or double-clear);
- Duketon and Edjudina grey-scale TMI pixel-image maps — **$250 + $16.65** sales tax each;
- Duketon and Edjudina colour TMI pixel-image maps — **$300 + $20** sales tax each;
- Duketon grey-scale and colour TMI pixel-image maps (purchased together) — **$500 + $33.30** sales tax;
- Edjudina grey-scale and colour TMI pixel-image maps (purchased together) — **$500 + $33.30** sales tax.

Further maps issuing from AGSO's The Granites 1993 airborne geophysical survey

AGSO has compiled a colour pixel-image map

Continued on p. 8

New publications and data releases

Costs quoted below are counter prices. Superscripts refer to postage and handling charges (see footnotes), which apply to most hard-copy products and must be added to the cost of an order.

Note that educational institutions may claim a 35% discount off the counter price of any text publication or map produced wholly by AGSO. This offer does not extend to data releases (including *Records*).

All orders may be charged to Mastercard/Bankcard/Visacard. Please quote cardholder's name, number, and expiry date when ordering.

Note that a sales tax, for which maps sold in Australia are eligible, does not apply to orders despatched overseas; for Australian orders, a sales tax registration number or exemption declaration is required in writing when the purchase is made, otherwise sales tax will be charged.

General

AGSO Journal of Australian Geology & Geophysics, volume 15, no. 3 *($40.00. Save by subscribing; call AGSO for details. Contents listed on p. 5)*[1].

AGSO Research Newsletter 21 (free)[1].

Record 1994/49. Government Geoscience Database Policy Advisory Committee geoscience data storage workshop, 29 August 1994, proceedings *(see announcement below; $40.00)*[1].

Record 1994/55. Creating Arc/Info coverages from Microstation design files — some procedures and AML routines; R. Brodie *($15.00)*[1].

Minerals & environment

1:250 000 Murray Basin Hydrogeological Map Series. Adelaide–Barker, South Australia (Sheet SI54–9, 13); S.R. Barnett *(Department of Mines, South Australia; $20.00 + $1.35 sales tax)*[1].

1:250 000 Murray Basin Hydrogeological Map Series. Cargelligo, New South Wales (Sheet SJ55–6); D.R. Woolley & R.M. Williams *(Department of Water Resources, NSW; $20.00 + $1.35 sales tax)*[1].

1:1 000 000 Bouguer anomaly map. Cape York Peninsula *(specially produced for the Cape York Peninsula Land Use Strategy; see announcement on p. 4).*

Airborne geophysical and digital-elevation-model maps and data (see announcements on p. 4 and 6).

National Landcare Program airborne geophysical data. Wanilla (SA), Serpentine (Vic.), and Cressey (Tas.) regions *(see announcement on p. 3).*

Record 1994/25. Mundaring Geophysical Observatory: 1986 to 1989; P.J. Gregson *($20.00)*[1].

Record 1994/28. Mawson Geophysical Observatory 1993: annual report and data summary; A. Rada *($20.00)*[1].

Record 1994/29. Geomagnetic report, 1993, Davis and Casey; A. Rada *($12.00)*[1].

Record 1994/47. Mundaring Geophysical Observatory annual report, 1993; P.J. Gregson, E.P. Paull, V.F. Dent, O.D. McConnel, L.A. van Reeken, & Y.M. Moiler *($20.00)*[1].

Record 1994/52. Quaternary climate in Australia: a bibliography; second edition; E. Bleys, G.R. Hunt, & M. Truscott *(compilers; see announcement on p. 2; $60.00*[3] *for hard copy; $30.00*[1] *for digital version).*

Record 1994/56. Australian Regolith Conference '94; C.F. Pain & I.D. Campbell *(compilers; see announcement below; $20.00)*[1].

Marine, petroleum, & sedimentary resources

Map folio. Eastern Otway Basin (11 maps at two scales; *see announcement on back page).*

Marine deep-seismic data. Carnarvon and Browse Basins *(see announcement on p. 3).*

Record 1994/1. Geology and geophysics of the offshore Maryborough, Capricorn and northern Tasman Basins: results of AGSO survey 91; P.J. Hill *(see announcement on p. 5; $200.00)*[4].

Record 1994/32 (CPC Catalogues 4). Catalogue of type, figured and cited specimens in the Commonwealth Palaeontological Collection: Vertebrata; A.C. Davis *(see announcement on p. 2; $20.00)*[1].

Record 1994/35 (CPC Catalogues 5). Catalogue of type, figured and cited specimens in the Commonwealth Palaeontological Collection: Conodonta; D.L. Strusz *(see announcement on p. 2; $30.00)*[2].

Record 1994/39. Eastern Otway Basin — horizon maps for the onshore areas at 1:250 000 scale; D. Finlayson (text only; *see announcement on back page; $50.00)*[1].

Record 1994/41. Geology and petroleum potential of Ragay Gulf, Tayabas Bay, northeast Palawan Shelf and Guyo Platform, Philippines (volumes 1 to 4: text, appendices, maps, and atlas; *see announcement on p. 14; $5000.00)*[5].

Record 1994/45. Phanerozoic magnetostratigraphy: a contribution to the timescales project — Palaeomagnetism Project 224.03; Phanerozoic Timescales Project 111.03; C.T. Klootwijk, M. Idnurm, H. Théveniaut, & A. Trench *($20.00)*[1].

Record 1994/46. Guide to genera file of fossil spores and pollen of Jansonius & Hills (1976); D. Burger *(see announcement on p. 5; $35.00)*[1].

Record 1994/53. High resolution seismic survey of the Exmouth, Barrow, and Dampier Sub-basins, North West Shelf, Australia: cruise proposal; K.K. Romine *($15.00)*[1].

A catalogue of AGSO publications on computer disk may be purchased from the AGSO Sales Centre for $15, which includes postage and handling charges. Once installed on an IBM-compatible computer, the catalogue can be searched via a menu screen.

[1]$5 in Australia, $15 overseas. [2]$10 in Australia, $25 overseas. [3]$15 in Australia, $45 overseas. [4]$25 in Australia, $60 overseas. [5]Courier charge applies.

"Australian regolith conference '94"

Abstracts of papers published by AGSO

A cosponsor of the "Australian regolith conference '94", which was held in Broken Hill between 14 and 17 November 1994, AGSO has published the abstracts of 51 papers presented at that meeting. The abstracts are packaged as an A4 spirally bound document of 59 + vi pages — *AGSO Record 1994/56* — which costs $20 + postage and handling charges of $5 (in Australia) or $15 (overseas).

'Geoscience data storage' workshop

Documentation of findings now available

In August this year, AGSO hosted a one-day workshop to address the issues faced in storing and managing large holdings of geoscientific information. Organised by the Government Geologists' Database Policy Advisory Committee (GGDPAC), which actively promotes and coordinates data management and standards issues, this workshop was well-attended by a cross-section of representatives from industry, data storage/management companies, Australian and New Zealand geoscientific agencies, and Australian Archives.

Several themes and issues were explored at the workshop — in particular:

- physical standards for storage media;
- data-access needs of users
- data management issues;
- overviews of industry and government data and tape holdings;
- data preservation and access projects; and
- future directions.

Some important lessons were exchanged on the advisability of using different media, the factors influencing data recovery on damaged media, and the time/brand reliability of 1980s tapes.

AGSO Record 1994/49, an 80-page documentation of formal presentations and findings at the workshop, is now available for $40 + postage and handling charges of $5 (in Australia) or $15 (overseas) from the AGSO Sales Centre.

For further information, contact David Berman on tel. (06)2499602, fax (06)2499977, or e-mail dberman@agso.gov.au.

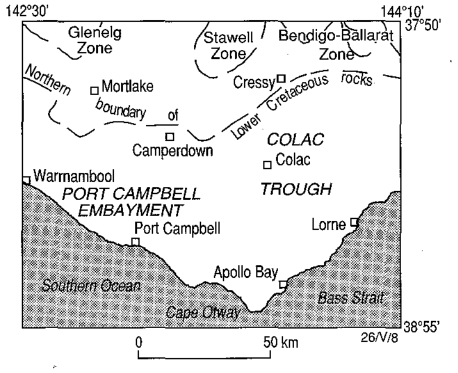
New horizon maps for the onshore eastern Otway Basin

During late September 1994 at the 12th Australian Geological Convention in Perth, AGSO released a folio of eleven maps of the eastern Otway Basin region as another contribution to the National Geoscience Mapping Accord (NGMA) project in the Otway Basin.

AGSO and the Victorian Institute of Earth & Planetary Sciences at Monash and LaTrobe Universities have interpreted and mapped four seismic horizons in the onshore eastern Otway Basin bounded by latitudes 37°50′–38°55′S and longitudes 142°30′–144°10′E. The seismic horizons are: top Palaeozoic basement, top Crayfish Group, top Eumeralla Formation, and base Wangerrip Group.

AGSO Record 1994/39 accompanies a folio containing the following colour maps produced from a Petroseis database:

- Bouguer gravity anomalies, Otway Basin, 1:1 000 000 scale;
- total magnetic intensity residual anomalies, Otway Basin, 1:1 000 000;
- Bouguer gravity anomalies, eastern Otway Basin, 1:250 000;
- two-way time (milliseconds, ms) to Palaeozoic basement, colour image and contours, 1:250 000;
- two-way time (ms) to top Crayfish Group, colour image and contours, 1:250 000;
- two-way time (ms) to top Eumeralla Formation, colour image and contours, 1:250 000;
- two-way time (ms) to base Wangerrip Group, colour image and contours, 1:250 000;
- isopach map (ms two-way time) for Crayfish Group, image and contours, 1:250 000;
- isopachs (ms two-way time) for Eumeralla Formation, image and contours, 1:250 000;
- isopachs (ms two-way time) for Sherbrook Group, image and contours, 1:250 000; and



Eastern Otway Basin map folio area.

- base map showing seismic lines, well locations, and general geological features, 1:250 000.

The maps are part of a new generation of maps for the onshore Otway Basin being published by AGSO and its NGMA partners. The Geological Survey of Victoria (GSV) is publishing a similar map folio for the central Otway Basin, and the Department of Mines & Energy, South Australia, is publishing a folio for the western Otway Basin.

The eastern Otway Basin map folio emphasises the complexity of Early Cretaceous rifting events along the northern margin of the Otway Basin, and shows the extent of the failed rift system in the Port Campbell Embayment and Colac Trough. The maps highlight features not previously recognised as part of the overall rift system. They also highlight the extent of the Late Cretaceous headwall faults in the Port Campbell Embayment that ultimately formed the landward (and eastern) limit of a lower plate margin during Australia–Antarctica separation.

Products for sale include:

- *AGSO Record 1994/39* (text only) — **$50**;
- *AGSO Record 1994/39* and map folio — **$700 + map reproduction costs (currently $220)**; and
- grid files of two-way times and time thicknesses for four horizons — **$2000 per data set.**

Other products — such as customised displays of data, maps at different scales, and isometric displays — can be produced to special order; prices will be quoted on application.

For further information about the eastern Otway Basin map folio and other aspects of the NGMA Otway Basin project, contact Doug Finlayson (tel. (06)2499761, fax. (06)2499972, e-mail dfinlays@agso.gov.au).

Airborne geophysical maps and data for NGMA projects

Continued from p. 6

of the digital elevation model (DEM) of the Highland Rocks 1:250 000 Sheet area (SF52–7), and gradient-enhanced pixel-image maps — in both colour and grey-scale — of total magnetic intensity (TMI, reduced to the pole) and its vertical derivative for the Highland Rocks and Mount Theo (SF52–8) Sheet areas; a colour pixel-image map of the Mount Theo DEM was issued earlier this year (see *AUS.GEO News 24*, for September–October 1994, p. 6). AGSO's The Granites airborne survey last year acquired the basic data for these maps along north–south flight lines 500 metres apart 90 metres above the ground.

Data for the DEM pixel-image map

The digital elevation model of the Highland Rocks 1:250 000 Sheet was produced by combining data from the survey aircraft's GPS with the aircraft's radio-altimeter record, as described for the Hann River DEM (p. 4), except that the GPS height data were sampled every 350 metres (5 seconds) and the profile data were gridded to a cell size of 105 metres (about 4 seconds) for the Highland Rocks model. A contour map of the model (as a dyeline or transparency), and the digital-point-located and gridded elevation data for it, were released mid-year (see *AUS.GEO News 22*, for June 1994, p. 6).

Data for the TMI pixel-image maps

The TMI images for the Highland Rocks and Mount Theo Sheet areas were compiled from processed total-field aeromagnetic data from which the International Geomagnetic Reference Field was removed. Minimum curvature was applied to grid the profile data to a cell size of 4 seconds of arc. Processing of the grid data in the spectral domain removed asymmetries introduced by the inclination of the Earth's magnetic field (i.e., they were reduced to the pole). For the colour image, histogram equalisation facilitated the selection of pixel colours from the natural palette (magenta high, blue low), and modulating the colour intensity and saturation enhanced the relief of the TMI gradient. The grey-scale image represents the first vertical derivative of the TMI grid data reduced to the pole.

For more information about the generation of these pixel-image maps, contact Peter Milligan on tel. (06)2499224 or fax (06)2499986.

Costs

- Highland Rocks colour pixel-image elevation map — **$300 + $20** sales tax.
- Highland Rocks and Mount Theo grey-scale gradient-enhanced pixel-image maps of TMI (reduced to the pole) and its vertical derivative — **$250 + $16.65** sales tax each;
- Highland Rocks and Mount Theo colour gradient-enhanced pixel-image maps of TMI (reduced to the pole) and its vertical derivative — **$300 + $20** sales tax each;
- Highland Rocks gradient-enhanced pixel-image maps of TMI (reduced to the pole) and its vertical derivative in colour and grey-scale (purchased together) — **$500 + $33.30** sales tax; and
- Mount Theo gradient-enhanced pixel-image maps of TMI (reduced to the pole) and its vertical derivative in colour and grey-scale (purchased together) — **$500 + $33.30** sales tax.

[1]AGSO has already released the resulting package of geophysical maps (TMI and gamma-ray spectrometric contours and profiles, and TMI pixel images) and data (digital point-located and gridded magnetic and gamma-ray spectrometric), and digital elevation models (contour maps and digital point-located and gridded elevation data; see *AUS.GEO News 20*, for February 1994, p. 6; *21*, for March–April 1994, p. 6; *22*, for June 1994, p. 6; and *23*, for August 1994, p. 6).

Marine seismic survey of the Otway Basin in progress

From late November, RV *Rig Seismic* will spend almost four weeks acquiring deep-seismic data in the Otway Basin and its surrounds in South Australian, Victorian, and possibly Tasmanian waters. This survey (no. 137) will consist of about 3500 kilometres of 192-channel 48-fold seismic profiling with a 4800-metre cable and a record length of 16 seconds.

The purpose of the survey is to identify the underlying crustal features and multiphased development history that produced the complex structure. Some lines will extend to the abyssal plain, and cross the continent–ocean boundary hundreds of kilometres offshore.

Neville Exon is the supervising scientist for the project; Jane Blevin will represent AGSO's Division of Marine, Petroleum & Sedimentary Resources aboard ship.

AGSO
AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION

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- For subscription enquiries, contact Charlie Modrak, tel. (06) 249 9111 (extn 9623), or 249 9623 (direct), fax (06) 249 9982
- For further information about the sale of products referred to in this issue, contact the AGSO Sales Centre, tel. (06) 249 9111 (extn 9519) or 249 9519 (direct), fax (06) 249 9982.

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AGSO's programs*

III. The International Program

Complementing AGSO's core activities, which are delivered through seven domestic scientific programs, the International Program facilitates the delivery of AGSO's contributions to a wide range of geoscientific projects. AGSO's International Program:

- coordinates geoscientific activities arising from: international agreements, development-assistance projects, and collaboration with other agencies involved in international work;
- promotes the exchange of information and the development of research between AGSO and other Australian and overseas agencies; and
- identifies commercial geoscientific opportunities relevant to AGSO's expertise.

AGSO's international activities may be broadly categorised into:

- contributions to the coordination of and/or participation in global geoscientific research;
- support of Australia's foreign-policy, trade, and development-assistance objectives; and
- contributions to commercial projects (including training and consultancies) which bring substantial benefits to AGSO's domestic programs.

AGSO deploys its own staff and engages consultants as required to fulfil its international commitments. AGSO further employs contract staff to continue the core activities in its domestic programs on behalf of permanent staff so deployed.

Over the past five years, AGSO has placed increasing importance on providing geoscientific services to agencies that fund overseas development projects. AGSO has contributed its services in the past to several such projects, mostly funded by the Australian International Development Assistance Bureau (AIDAB). AGSO is now seeking funds for such projects from other sources farther afield: the Asian Development Bank (ADB), World Bank (WB), United Nations (UN), and recipient governments (RG).

International development-assistance projects recently completed by AGSO have consisted mostly of geoscientific mapping, offshore seismic framework studies, and airborne geophysical surveys. While continuing to participate in such operations, AGSO is now also turning its attention to evaluating and managing environmental problems — particularly groundwater — and developing GIS-related database systems.

AGSO's first development-assistance project was the 1979–89 AIDAB-funded geological–geophysical mapping in Indonesia — western Irian Jaya and west–central Kalimantan. AGSO has just started a geoscientific mapping project in Argentina (RG), and has submitted proposals for similar projects in Vietnam and Laos (AIDAB) and Iran (RG).

AGSO completed an offshore seismic framework study in the Philippines (AIDAB) this year, and has submitted proposals for similar studies in Taiwan, PNG, Vietnam, and Indonesia (also AIDAB). Proposals have also been submitted for upgrading the capabilities of an Indonesian research vessel, and for establishing an Indonesian petroleum open-file database (AIDAB).

AGSO has designed and supervised an integrated airborne geophysical survey in Oman (RG), is currently supervising an airborne survey in Vanuatu (AIDAB), and has submitted proposals for other surveys in Oman (RG), Indonesia (ADB), and the Philippines (AIDAB).

Recently completed groundwater studies as contributions to the rehabilitation of Nauru (RG and AIDAB) have given way to a water-quality management project in Kathmandu (AIDAB via

Continued on page 13

* An occasional series. Parts I and II appeared in *AUS.GEO News 24*, for September–October 1994.

AGSO commences geoscientific mapping in Argentina

AGSO will employ advanced mapping and state-of-the-art spatial technology in a multidisciplinary geoscientific project recently commenced in the Argentine Republic. Funded by the Argentine Government as part of a broader initiative to develop Argentina's minerals industry, the project is a cooperative one between the Argentine Mining Secretariat and AGSO. A major part of this initiative is to update the geoscientific knowledge base, to provide a modern framework for exploration and resource development.

The two-year project is being conducted in collaboration with scientists of the national geological survey of Argentina, and operating from the survey office in Córdoba. Focusing on the southern Pampean Ranges in the provinces of La Rioja, Córdoba, and San Luis, it will build on the existing information established through past geological mapping and investigations by the Mining Secretariat, provincial mining services, and universities.

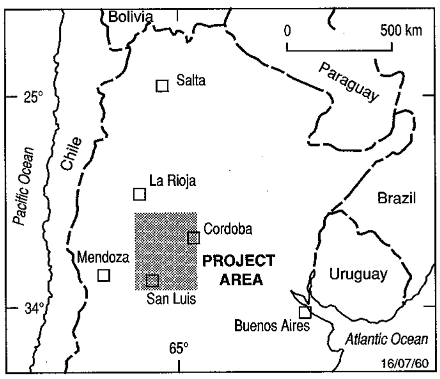
Project area

The project area covers 27 000 square kilometres in the Pampean Ranges, where Precambrian to lower Palaeozoic metamorphics and granite crop out at the eastern margin of the Andean Mobile Belt. It was peneplaned in the Cretaceous and intensely faulted (and thrusts formed) in the Pliocene to Pleistocene. The resulting landscape comprises easterly dipping tilted faults and basement fault-blocks separated by Neogene sedimentary basins.

The area contains metallic deposits in both the metamorphic and igneous rocks, but is best known as a producer of industrial and construction materials. Mineral resources include gold and polymetallic (gold, silver, lead, zinc) vein deposits, and past production includes tungsten, bismuth, tin, and manganese. The project area includes the mining districts of La Candelaria, El Guaico, La Argentina, La Bismutina, and Agua de Ramon in Córdoba Province; the La Carolina epithermal gold district in San Luis; and the Las Callamas gold district in La Rioja.

Methodology and output

A low-level airborne magnetic and gamma-ray spectrometric survey will be flown soon along lines 500 metres apart. The resulting geophysical data, and Landsat Thematic Mapper (TM) data, will provide a basis for ground geological and metallogenic mapping. The geological mapping will focus on structural relationships, and be supported by precise geochronological and other laboratory studies. Other new technologies, such as relational databases, will also support the mapping. An important component of the project will involve institutional strengthening through the transfer of technology and skills.



Location of the project area, Sierras Pampeanas.

The project will generate a range of products, including geophysical image maps, digital elevation maps, geological maps, structural geology maps, Landsat TM imagery, basement geology maps, metallogenic maps, databases, reports, and geographic information systems. These will provide a new geoscientific knowledge base to promote exploration in the area.

Australian–Argentinian associations, and project generation

Australian companies are presently at the forefront of exploration and resource development in Argentina. MIM through Mineria Alumbrera — a joint venture with International Musto Explorations Ltd — will invest US$600 million in the development of the world-class Bajo de Alumbrera porphyry Cu–Au deposit in Catamarca Province. Other Australian companies that are active there include CRA (Famatina prospect) and BHP Minerals.

The project was conceived during the visit to Australia in March 1993 by a high-level mining delegation headed by Mining Secretary Maza. During this visit, AGSO and the Mining Secretariat signed a Letter of Intent for long-term cooperation in geoscientific mapping and research. The subsequent development of a Technical Cooperation Memorandum was greatly assisted by the Austrade Offices in Santiago (Senior Trade Commissioner, Mr Mike Moignard), and Buenos Aires (Trade Commissioner, Dr César Fernandez) and strongly supported by Australia's Ambassador to Argentina, Mr Hugh Wyndham. The signing of the AGSO Technical Cooperation Memorandum follows the signing in May this year by Senator McMullan, Minister for Trade, of a Memorandum of Understanding on Cooperation and Consultation between Argentina and Australia.

More information from Dr Lynton Jaques (Chief, Division of Regional Geology & Minerals; tel. 61–(0)6–2499745, fax 61–(0)6–2499983).

AGSO

Australian Geological Survey Organisation

a research organisation of the Department of Primary Industries & Energy

Advancing heat-flow technology for investigating submarine volcanic hazard in Rabaul Harbour ...

... and for possible application in offshore petroleum exploration

AGSO recently completed a five-year investigation of heat flow in Rabaul Harbour (Papua New Guinea), which formed from the sea invading a 300-metre-deep caldera. A report documenting the results of the investigation has been lodged with the funding agency, the Australian International Development Assistance Bureau (AIDAB).

Rabaul Volcanological Observatory (RVO) scientists defined a dilemma for the emergency services of the PNG Government in the mid-1980s. They ascribed intense seismicity originating in Rabaul Harbour, and uplift of the harbour floor at two locations, to the upwelling of magma from a reservoir 4 kilometres below the seabed. The location of the magma reservoir beneath the sea made it inaccessible to conventional monitoring by observatory staff.

At the request of the PNG Government, AIDAB engaged AGSO in 1989 to undertake a heat-flow survey of the harbour, in order to map the distribution of heat transfer through the harbour floor. At that time, heat-flow-sampling technology was not sufficiently advanced to meet the special requirements of working in water as shallow as at Rabaul, where temperature effects from seasonal currents can distort the measurements of heat flow.

According to AGSO principal investigator, Trevor Graham, 'Successful shallow-water sampling of heat flow requires an 8-metre penetration of a probe into the seabed, and 32 thermal measurements to be taken along the probe in order to isolate the true thermal gradient.'

Trevor and a team of collaborators from RVO, the South Pacific Applied Geoscience Commission, the University of PNG, and Applied GeothermEx Pty Ltd set about designing and testing a probe that would meet these requirements. A suitable probe emerged after three generations of designing and testing.

The final design, comprising several interchangeable segments, allows the thermal measuring devices (thermistors) to be in direct contact with the seabed sediments yet not impede penetration, which is driven by a vibration head powered by a 415-volt power supply. Electronic devices facilitate the measurement in real time of both the tilt of the probe's frame on the seabed, and its penetration to an accuracy of 1 centimetre. A sophisticated electronics package fitted to the submerged frame records thermal measurements.

Applied to a survey in Rabaul Harbour in November 1992, the new probe measured thermal profiles at 20 sites, and recovered 17 long sediment cores. The resulting data, combined with those from a test survey, provided enough information for Trevor and his team to establish the distribution of heat flow in the harbour.

Modelling of the data located two anomalies due to very high heat generation, neither of them coinciding with the two sites of harbour-floor uplift. One of the anomalies was associated with Tavurvur volcano, one of the two volcanoes which erupted with devastating consequences for the inhabitants of Rabaul in September–October this year; the other volcano that erupted at the same time, Vulcan, was not associated with a heat-flow anomaly. The second anomalously high value might reflect local hot-spring activity.

Plans to install permanent stations that would measure changes in the harbour's heat flow, and therefore provide a warning of impending eruption, will be reviewed after more pressing decisions about the sociological future of Rabaul have been made. Even so, there is no disguising the probe's potential impact for coastal communities living with the continuous threat of volcanic eruption: it has facilitated the development of a shallow-water system for monitoring volcanic heat fluxes. Further, the advances in technology pioneered by the investigating team have provided a method for systematic submarine heat-flow investigations at shallow depths, which may find application in the search for petroleum offshore.

More information from Dr Trevor Graham (tel. 61-(0)6-2499341, fax 61-(0)6-2499986) or Dr Wally Johnson (tel. 61-(0)6-2499377, fax 61-(0)6-2499983).

AGSO contributes to the planning of rehabilitation on the island of Nauru

According to the terms of the 'Nauru/Australia rehabilitation feasibility study', the Australian Government is helping to plan rehabilitation of the island of Nauru, an independent nation in the central Pacific Ocean which has been devastated by a century of mining; excavation of phosphate has reduced the inland plateau of Nauru to a series of karst pinnacles up to 15 metres high. On behalf of the Government, the Australian International Development Assistance Bureau engaged AGSO as hydrogeological consultants to identify freshwater-supply sources on the island, and recommend how to optimise their exploitation.

Hydrogeology and water supply

The Nauru Government's Commission of Inquiry into Rehabilitation of the Worked-out Phosphate Lands engaged AGSO (then BMR) as a hydrogeological consultant in 1987. Then, geophysical surveys by AGSO had indicated that about 500 metres of limestone cap the seamount beneath Nauru. Joints in the limestone open up by karstification, creating a permeable substrate that allows ingress of sea water beneath the island. Drilling that year for the Commission of Inquiry proved open-jointed limestone to a depth of 50 metres below sea level, the maximum depth drilled.

These investigations showed that fresh water occurs in two areas on the island: in the north-centre and south-centre. The fresh water forms a layer 4–7 metres thick overlying a much thicker layer of brackish water, whose salinity increases downwards. Sea water occurs at a depth of about 80 metres below sea level.

Fresh water that is currently accessible to the Nauru people, who live in communities along the coast, is insufficient to satisfy their domestic needs. It is derived from rainwater tanks supplemented by shallow wells, some of which are brackish. The shortfall in fresh water is met by purchasing tankered desalinated water.

Rainwater is particularly important: it is the best-quality water for domestic use, and reduces the people's dependence on centralised systems. However, the generally high Nauru rainfall is offset by a 4-month dry season, and by the El Nino effect, which causes periodic drought. This source of water should be optimised by using all available roof space as a rainwater catchment, and by enlarging tank-storage facilities.

Groundwater is abstracted from several hundred shallow wells on the coastal terrace. Regarded as a second-class water source, it is used for sewage, gardens, and other secondary domestic purposes, and as a back-up domestic supply in drought years. Well-water quality varies: about one-third exceeds the World Health Organisation limit for drinking water (1500 milligrams per litre total dissolved solids); about half is polluted bacteriologically. The coastal-terrace groundwater would have to be treated extensively before it could be used as a source of drinking water.

Groundwater exploitation limits

AGSO and the Australian National University recently simulated the Nauru Island groundwater system in a mathematical model. Calibrating the model with measured salinity profiles, and applying to it the simulated pumping of bores at different rates, enabled the effects of salt-water upconing to be computed. Accordingly, the model has provided invaluable data that can be applied to the effective managemement of the freshwater resource in the centre of Nauru: bores, spaced at least one kilometre apart, should be constructed so as to draw water only from the top two metres of the freshwater layer; the safe pumping rate would be 1 litre per second (equivalent to the rate of groundwater recharge — 800 millimetres per year), but an increase to 2 litres per second may be permissible for short periods in the thickest part of the freshwater layer.

Consequently, a borefield with four bores pumping 1 litre per second and four bores pumping 2 litres per second could be developed in the centre of Nauru. Producing about 400 cubic metres of fresh water per day, the borefield would be suitable for helping to establish plantations in areas under rehabilitation during the dry season and periods of drought. Trickle irrigation would help to minimise water loss through evaporation. The aquifer would be recharged during the wetter periods.

More information from Gerry Jacobson (Project Manager for AGSO; tel. 61-(0)6-2499758, fax 61-(0)6-2499970) or Col Simpson (Chief, AGSO Division of Environmental Geology & Groundwater; tel. 61-(0)6-2499368).

AGSO helps locate copper–gold deposit in Oman

Hugging the Arabian Gulf and the Indian Ocean, the Sultanate of Oman may seem an unlikely place for Australian Government geoscientists to work. Even so, earlier this year, AGSO completed a three-year contract there with the Omani Ministry of Petroleum & Minerals.

In early 1990, the Ministry of Petroleum & Minerals asked AGSO (then BMR) to provide one or two geoscientists, experienced in geological and geophysical mapping, as consultants to help prepare tender documents for a combined geophysical and geological survey in selected areas of the Sultanate of Oman. Accordingly, AGSO's Lynton Jaques and Ian Hone visited Oman to review all available data, design an appropriate project, and develop specifications for the proposed survey — in the Batinah coastal and highly prospective Raki-Hayl as Safil (RHS) areas. The tender documents for the survey were completed at AGSO and forwarded to the Ministry in April 1990. As a result of their visit, the Ministry awarded a contract to AGSO to assess tenders and supervise the survey. AGSO evaluated the tender bids that were submitted, offered advice for awarding the contract, and recommended appropriate survey procedures.

Purpose and objectives

The survey was designed to map the distribution of rock units and structures, especially those beneath the Plio-Quaternary cover in the coastal area. Of particular interest in this area was the mapping of the subsurface distribution of the upper units of the Samail Ophiolite, which are prospective for base metals — particularly copper. Subcropping Samail Ophiolite in RHS, and a gossan identified there in 1985, helped to secure the inclusion of this area in the survey. In addition, the survey would constitute a pilot for assessing the applicability of systematic geophysical mapping throughout the country at a later date.

The survey's main objective was to generate data necessary for assessing the mineral potential of both areas. The data, and maps derived from them, will also assist studies of the groundwater resources and hydrocarbon potential in the sedimentary rocks below the Batinah coastal area.

Airborne geophysical component of survey

The first stage of the survey was a high-resolution airborne geophysical survey along lines 200 metres apart 80 metres above the ground. The contract for this was awarded to World Geoscience Corporation, an Australian company, which acquired 49 351 kilometres of aeromagnetic and gamma-ray spectrometric data over the two areas between January and April 1992. AGSO provided on-site supervision for the survey, and sent Mario Bacchin on two supervisory visits to ensure that the adopted procedures and acquired data met the technical specifications. In addition copies of the digital data were forwarded to AGSO in Canberra for quality control.

The resulting survey output from the contractor included point-located and gridded digital data, and a suite of maps (profile and contour) and images at 1:50 000, 1:100 000, and 1:250 000 scales, which were used as a basis for the field mapping and the geological interpretation. From the geophysical data, the contractor also generated a series of interpretation (geomagnetic) maps.

Field geological component of survey

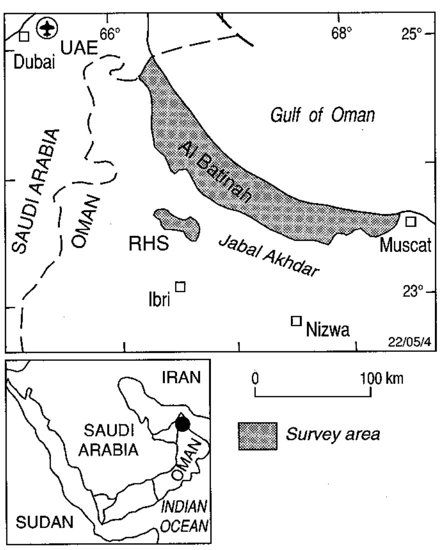
AGSO's Peter Stuart-Smith undertook the final stage of the survey in October–November 1992, when he visited the two survey areas in order to provide the field control necessary to interpret the geophysical data. His work greatly increased the prospectivity of northern Oman for further copper discoveries by identifying extensively subcropping basalt (part of the Samail Ophiolite), host rocks to copper deposits elsewhere in Oman. He also identified widespread and locally mineralised areas of alteration that correspond with demagnetised zones in the basalt.

After integrating these and previous geological observations with their interpreted geophysical data, World Geoscience Corporation derived a series of solid geology maps for the two areas. The magnetic signatures of the rocks distinguish the areas of alteration on the interpreted solid geology maps.

Outcomes

The Omanis judged the survey to be a success as it led to the discovery of a new copper–gold deposit in the RHS area. The magnetic anomalies derived from the survey facilitated the mapping of the volcanic host rocks. A follow-up ground geophysical survey (by World Geoscience Corporation under a subsequent contract) using transient electromagnetic and induced polarisation techniques identified exploration targets in the volcanics. A hole drilled to test an electrical anomaly intersected 8.35 metres of massive sulphides assaying 2.64% Cu and 1.04 grams per tonne of Au.

More information about the geophysical component of the survey from Dr David Denham (Chief, AGSO Division of Geophysical Observatories & Mapping; tel. 61–(0)6–2499267, fax 61–(0)6–2499986), and about the geological component of the survey from Dr Lynton Jaques (Chief, Division of Regional Geology & Minerals; tel. 61–(0)6–2499745, fax 61–(0)6–2499983).



Locations of the two survey areas.

Groundwater pollution — Nepal

Continued from page I4

Objective and purpose

The objective of the project is to generate reliable data (i) for assessing the groundwater quality of the Kathmandu valley and the extent to which the two aquifers are polluted; (ii) for quantifying the water resources; (iii) for managing these resources in the future; and (iv) for determining the feasibility of implementing groundwater protection measures. The derived information will form the basis for management decisions on water supply and environmental protection by government agencies, and will be available to aid donors. It is also expected to contribute to the development of a groundwater protection strategy.

The project will also generate baseline data for monitoring Kathmandu's groundwater system.

Implementation

The project espouses the Australian Government's stated principle of considering ecologically sustainable development as a key objective of technical cooperation projects. Scheduled to extend from November 1994 to November 1995, it will combine the professional skills of AGSO and GWRDB. The incorporation of a training component in the project will enable Nepalese hydrogeologists and chemists to participate briefly in field and laboratory work for AGSO's 'Australian groundwater quality assessment' project.

Groundwater quality data for the Kathmandu valley initially will be assembled from various sources, and a database established. Groundwater will be sampled from about 100 bores in the shallow aquifer and about 50 bores in the deep aquifer. Sampling of the bores, and chemical and bacteriological analyses of the groundwater samples, will be carried out in two phases: in the first, bores will be sampled on a broad scale to determine the possible extent of pollution; in the second, sampling will focus in more detail on problem areas defined by the results of the first phase, and on particular pollution sources and particular environmental tracers. If necessary, more specific analyses for environmental parameters will be done in Australia, but the GWRDB laboratory facilities will be upgraded as far as possible to ensure that the groundwater can be tested there for an adequate range of environmental parameters.

The groundwater database will be linked to a geographic information system, to facilitate the output of maps showing the extent of specific pollutants. The GIS will also facilitate the overlay of surface-water-quality information and maps of pollution sources, and enable the project team to identify land and water management problems.

More information from Gerry Jacobson (Project Manager for AGSO; tel. 61-(0)6-2499758, fax 61-(0)6-2499970) or Col Simpson (Chief, AGSO Division of Environmental Geology & Groundwater; tel. 61-(0)6-2499368).

AGSO's International Program

Continued from front page

Australia's Ambassador to Nepal), and a contribution to an Indonesian coastal zone study (AIDAB) coordinated by the Australian Marine Science & Technology Organisation. Environmental projects dominate most WB, ADB, and UN aid programs, and AGSO is investigating such projects with potential in southeast Asia and Africa.

More information from AGSO's David Newham (Head, International Business Unit; tel. 61–(0)6–2499571, fax 61–(0)6–2499990) or Alex Nicolson (Director, Division of Marketing & Corporate Relations; tel. 61–(0)6–2499411).

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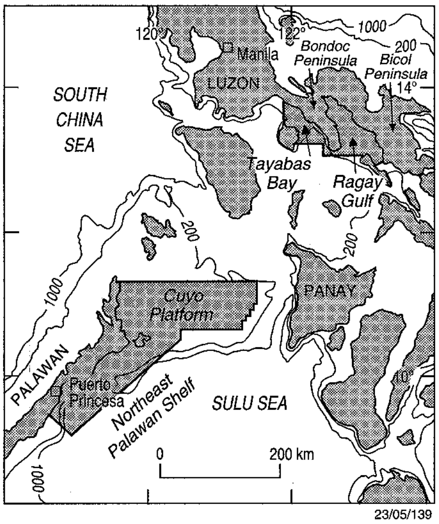
A collaborative offshore survey boosts petroleum exploration in the Philippines

In September 1988, the Philippine Government formally requested Australia's help to develop an offshore seismic survey program in selected basins of the Philippines.



RV Rig Seismic's survey areas (red screen) in the Philippines.

The Australian International Development Assistance Bureau (AIDAB) asked AGSO to review the request. This was done in December 1988 in consultation with geoscientific staff of the Philippine Department of Energy (DOE), and identified offshore areas where additional seismic data might promote exploration and the discoveries necessary to reduce Philippine dependence on imported petroleum.

Objectives and activities

Subsequent meetings in Manila and Canberra defined the following objectives for the project:

- to improve the knowledge of petroleum prospectivity of selected areas, and promote potential opportunities for future Philippines–Australia joint-venture exploration; and
- to assist the Philippine Government to acquire the skills to plan effective seismic surveys; to obtain and interpret seismic data and other petroleum resource-related information; and to use these to focus future petroleum exploration.

The project comprised four major components: data acquisition and processing; data interpretation and presentation; training; and project management, monitoring, and promotion.

Data acquisition and processing

AIDAB approved funding for the project in December 1991. Between March and May 1992, Australian and Filipino scientists and technicians aboard AGSO's RV *Rig Seismic* surveyed four areas — northeast Palawan Shelf, Cuyo Platform, Tayabas Bay, and Ragay Gulf. They acquired 2750 kilometres of 192-channel seismic data, 6000 kilometres of direct hydrocarbon detection ('sniffer') data, and other geophysical (gravity, magnetic, and bathymetric) data.

A palynological study was commissioned in an effort to improve age dating of sediments encountered in exploration wells. Samples of oil and gas were collected from natural seeps and old exploration wells in the Bondoc and Bicol Peninsulas, to investigate the types, depositional environments, probable ages, and maturation levels of the rocks in which they were sourced.

The seismic data were processed in Australia, integrated with reprocessed exploration data from other sources, and interpreted for petroleum potential; AGSO staff provided on-the-job training to DOE personnel in these facets of the project. This work started in June 1992 and finished on schedule and below budget on 30 June 1994.

Benefits and outcomes

The project provided the following benefits to the Government of the Philippines:

- independent assessments of the petroleum resource potential, and information necessary for designing, awarding, and managing exploration permits;
- up-to-date petroleum databases in four areas;
- an Australian-designed computer-based mapping system to assist with continuing studies of all Philippine sedimentary basins;
- training of Filipino scientists in many aspects of petroleum exploration which will enable DOE to carry out similar basin analyses in the future; and
- increased industry awareness of petroleum potential in the Philippines.

The project had a total budget of $A5.011 million, of which AIDAB contributed $A4.881 million and the Philippine Government the rest.

The results revealed eight oil and gas prospects and leads in the Ragay Gulf, three in each of Tayabas Bay and the northeast Palawan Shelf, and one in the Cuyo Platform. The basic data and analyses of regional geology, structure, basin evolution, and petroleum prospectivity were made available initially to interested Philippine and Australian petroleum exploration companies who were part of a 34-company consultative group.

DOE opened the Ragay Gulf area for petroleum permit applications in October 1993 and the remaining three areas in April 1994. One consortium — consisting of Australian, Philippine, and American oil companies — was awarded a permit in western Ragay Gulf. Other companies — including Shell, Mobil, Arco, and Santa Fe — are currently evaluating the survey data from the Ragay Gulf with a view to taking up acreage in the near future.

Products

AGSO has issued the survey results as a hardcover four-volume package — *Record 1994/41*, which costs $5000 + courier charge. Volume 1 (text) comprises a separate, illustrated report for each area surveyed. A comprehensive collation of appendices (volume 2) includes geohistory models of the four areas, and geochemical and palynological analyses. Volume 3 comprises 36 large-format monochromatic time–structure and bathymetric maps, and volume 4 is an atlas (roughly B1) of 30 colour folios (regional structure maps, and montages describing in detail each of the hydrocarbon prospects revealed by the project).

AGSO also has seismic sections and stacked tapes available for sale.

More information on the survey and its outcomes from Dr Chris Pigram (acting Chief, Division of Marine, Petroleum & Sedimentary Resources; tel. 61–(0)6–2499327, fax 61–(0)6–2499986); and on products from Chris Johnston (tel. 61–(0)6–2499353, fax 61–(0)6–2499981).

Assessing groundwater pollution in Nepal

AGSO has just started work on a collaborative technical project with Nepal's Groundwater Resources Development Board (GWRDB).

This project evolved after a poster on groundwater pollution in the Kathmandu valley had aroused the interest of AGSO principal research hydrogeologist, Gerry Jacobson, at an international hydrogeological conference. Believing that his skills and experience would enable him to help find a solution to the pollution problem, Gerry visited the area, held discussions with GWRDB officials, and outlined a remedial plan to the Australian Ambassador to Nepal. Impressed by Gerry's plan, Her Excellency Annmaree O'Keefe is donating up to $100 000 to fund the project.

The problem

An environmental crisis has struck the Kathmandu valley, which supports a burgeoning population of over one million city dwellers. The valley has several interrelated environmental water problems, including a meagre and contaminated water supply: domestic water is supplied to the city for only two hours a day, and commonly carries pathogens. The sewerage system is inadequate, so much of the waste ends up in the rivers. An uncontrolled expansion of the carpet industry has resulted in up to 1000 factories releasing toxic effluent into the environment. Problems are compounded by deficient solid-waste-disposal practices, lack of urban planning, and ineffective environmental protection legislation.

The pollution now appears to be affecting the tourist industry, a vital contributor to the Nepalese economy; in 1993, the number of tourists apparently decreased by 15 per cent from 1992.

Groundwater constitutes 50 per cent of the Kathmandu city water supply. It is abstracted from both shallow and deep alluvial aquifers. The shallow aquifer apparently is polluted, and parts of the deep aquifer may be too. However systematic, reliable data on groundwater quality are lacking.

Continued on page 13

AGSO
AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION

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Appendix (4)

300087

CONDOR OIL INVESTMENTS

NORTH BRUNY ISLAND

A PROGNOSIS FOR A STRATIGRAPHIC HOLE

INTRODUCTION

The well defined and described in this prognosis is the first well to be drilled by Condor Oil Investments in Tasmania.

The site chosen stands above Variety Bay on the eastern coast of North Bruny Island and overlooks Storm Bay. See Figure 1.

Location: 533 900 mE
5215 000 mN
~25 mASL

BACKGROUND INFORMATION

Petroleum products have been reported on North Bruny Island for several decades and active exploration was undertaken more than sixty years ago.
Several wells have already been attempted in the Great Bay and Big Lagoon region. All have been limited by the funds and equipment available. The details of this drilling and the companies involved were described by Bendall (1991).

The most important of these wells was Johnstone's Well drilled in 1929. The site is shown in Figure 1. Although it reached a depth of less than 50 m and no reliable records of formations or hydrocarbons encountered have survived some oil was recovered. It was a light oil and was stored in drums at the site. It was not analysed and none has been preserved. Its source is unknown. The well did not penetrate deeply into the Permian succession due to jamming.
The deepest drilling in the area, at the north end of the isthmus, was to 135 m and this does not appear to have encountered the thick dolerite sheet which could have been expected at this approximate depth.
Any hydrocarbons found in the area, or these holes, must have drained from, or through, the Deep Bay and, more probably, the Minnie Point Formation which includes porous sandstones.
A number of other seepages have been reported in this same general area and all occur in rocks at about the stratigraphic level of the Minnie Point Formation. All these units are Permian in age. Many of these seepages, and tar coatings, have been found around Variety Bay.

The knowledge of this old drilling programme and the company behind it was forgotten for nearly sixty years. As were the seepage reports.

Exploration was renewed by Conga Oil in 1984. The new exploration incorporated an initial literature search and relocation of reported seepage sites. The site of Johnstone's Well was found and samples taken of muds, soil and local fluids. These confirmed the trace presence of hydrocarbons and the chemistry was consistent with a source within the Ordovician Gordon Group limestones of southern Tasmania. Unfortunately the trace amounts recovered do not permit any definite conclusions or complete appraisal of the oil - as might a small jar of the actual oil.
The exploration was expanded to include regional gravity and magnetic surveys (Figures 2, 3) which were interpreted to suggest that possible source rocks may exist to the west and southwest but were most unlikely beneath North Bruny Island itself (Figures 5, 7). This was essentially confirmed by the trial seismic traverse along the ridge from Trumpeter Bay to Church Hill (Figure 4). The geophysical analyses were primary and regional but did provide an understanding of the setting of the region, possible locations of critical structures and older basins, and a context for migration paths (Figure 6). Some work was begun to crystallize the detailed local setting of North Bruny Island but this work was never funded nor completed. Samples of the initial analyses are reproduced in Figures 8 and 9 and this incompleted evaluation provides the information used for location of the present well proposal. Complete details of the status of exploration studies (geophysical and geochemical) actually completed may be found in Leaman (1990, 1991 and Carne, 1992).
There remains scope for much more work but further work would be enriched by some new control information; including depth to basement and seismic velocities.

The seepages recorded in the area can be understood in terms of the structures described regionally. A reservoir to the west, sealed by the base Permian unconformity, may leak up dip to the large dolerite feeder near Ford Bay or the faults marginal to Storm Bay which were reactivated throughout the Tertiary. Given the thermal history of the region it is possible that actual generation did not commence until the Cretaceous and may still be occurring (see Carne, 1992).

Earlier drilling programs may have intersected some near surface migration paths. As would the newer fault fracture systems. All leakage appears to occur slowly and there is no evidence of any high pressures. The association of seepages with seismic activity also suggests a tight, low volume system above the unconformity or seals.

Consequently any new well drilled in the North Bruny region must have a conceptual or stratigraphic basis with the direct aim of further sampling any migration paths and confirmation of sequence.
Such a well would provide proof that oil is indeed migrating through a viable fracture net and that either generation is continuing or that there may be a large reservoir nearby. A reasonable sample would also resolve many of the source and generation issues since it would allow exhaustive chemical analysis.
These are the primary objectives of this well.

HISTORY OF PROPOSALS

Conga Oil proposed re-drilling of the Johnstone's Well site in 1987 in order to prove the veracity of the old records, obtain a small sample and complete chemical appraisals. The recovery of even a small sample from a fracture or bedding seepage would also have been of considerable financial benefit to both the project and the company since it would have established that parts of Tasmania do have petroleum potential - a possibility that had been long dismissed in both large company and government circles and whose attitudes made financing of the exploration difficult indeed. The company itself had sufficient confidence in the project to employ a drilling engineer, review used equipment in North America, and to purchase a rig with a capacity in excess of 2500 m. This equipment was never imported into Australia for reasons beyond the scope of this prognosis and became the source of considerable financial loss to the shareholders.

Drilling of the site was again proposed in 1991 (Bendall, 1991).

Final stage evaluation of the geophysical and structural information available, however, did indicate that the Johnstone's Well site may not provide an optimal stratigraphic section. The nearness of a dolerite feeder and the risk of thickened dolerite coupled with a higher stratigraphic level meant that any hole at the old site may be several hundred metres deeper than one across the hill. This issue became important to the company felt the loss of its own drilling equipment and funding became more restricted in the 1990-1993 period .

WELL PROGNOSIS

Any drilling programme is dependent on the exploration undertaken and in this case only limited regional analysis has been completed.
Site selection has been judged, therefore, on the basis of minimum depth to basement (in order to establish the stratigraphy of the region), the loci of seepages (in order to maximise opportunities to sample the migration path) and good drilling conditions.

No formation older than the Deep Bay Formation outcrops on North Bruny Island and the site selected lies near the top of this formation.

The prognosis for the well is

Surface to 20 m	Minnie Point Formation	sandstone/siltstone
20 - 50 m	Deep Bay Formation	foss. mudstone
50 - 400 m	dolerite	
400 - 450 m	Deep Bay Formation	foss. mudstone
450 - 550 m	Bundella Formation	foss. mudstone
550 - 700 m	Woody Island Siltstone	mudstone
700 -1000 m	Truro Tillite	tillite
unconformity		
1000 -	Precambrian schists	

Some key unknowns are included in this prediction.
a) Thickness of dolerite. 350 m is an average estimate.
b) Only one dolerite sheet is presumed. Two are possible but a basal sheet may be relatively thin.
c) Thickness of tillite. This may vary from nil to 700 m.
d) Thickness of the Deep Bay and Bundella Formations. The estimates are representative of local formations but a variation of up to 50% is possible.

Items c) and d) depend upon the location of this site with respect to the basin deposition axes. All formations older than the Minnie Point Formation may occupy active rift stages and their thickness thus depends on the location of this site with respect to the block rotation of the rift. Insufficient work has been completed in southern Tasmania to establish this with certainty but if older structures have been rejuvenated then it is possible that this eastern location is comparable with Glenorchy where the tillite was absent.

Hydrocarbons seepages could be encountered at any level and very careful monitoring of fluorescence within the core recovered will be essential. The site itself has been selected with regard not only to the position of exposed faults disturbed along the Storm Bay coast during the Tertiary but also the likely Jurassic disposition of faults - several of which are either no longer exposed or disguised by intrusions. A comparison of Figure 8 and the regional geological map of the area (Kingborough) will indicate some of these differences. The surface geological map is not, in itself, a reliable guide to fracture foci or faults. The coalescence of structures east of Church Hill and south of Variety Bay may well account for the number of small seepage sightings in this part of the island.

The well will also be used for seismic velocity tests in order to permit review and reprocessing of seismic data.

WELL REQUIREMENTS

Type of well:
Two types of petroleum-related wells may be defined (e.g. Carne, 1991):
1. Exploration well (wildcat) is one drilled to discover whether previously untested trap conditions contains oil or gas, and
2. Stratigraphic well drilled solely to obtain subsurface information on sediments, structure, organic maturity and provide control for geophysical purposes.

The proposed well falls within the second category.

No specific target or source is proposed; indeed, all regional work suggests that the primary target for wildcat drilling lies several kilometres to the west.

The well will be a small diameter diamond hole ('N') which will be continuously cored (a shallow pre-collar may be prepared - option).

A diamond hole to a depth of 1000 m needs few special requirements beyond those normally specified for control of drilling fluids, access and landholder compensation.

Comments on equipment experience:
The history of all previous drilling of this type within Tasmania supports this view. No Mines Department diamond drilling has ever required any special equipment, including the 1000 m hole at nearby Woodbridge. No problems have ever been encountered with high pressure hydrocarbons including the Douglas River hole drilled by the department, and which is still flowing gas. Other drilling in regions with oil shale, whether for the shale or for groundwater, have ever posed pressure problems. The much deeper mineral exploration holes in western Tasmania have, likewise, not presented any experience of problem conditions even though gas risks may increase with depth in any basement type.
The Variety Bay area is not noted for large seepages, or very gassy ones, and there is no ground for any expectation of incidents. The load of a full drill stem in a limited diamond hole is clearly safe given all past experience. Were special regulations to be imposed on this hole, as has been suggested to the company, then this company would respectfully insist that they should also be applied to every water bore in Tasmania and all mineral holes in western Tasmania as well. It would also ask why government drilling did not operate to comparable standards.
Quite different requirements might well apply to a hole aimed directly at a fully investigated petroleum reservoir structure drilled using standard exploration open hole mud-control methods. This is not such a hole.

Detection of hydrocarbons:
It is expected that fluoresence methods will be required to detect any hydrocarbons in the hole/core since no large flows are anticipated in any formation given the seepage styles and seismicity relationships.

HOLE NAME

The name designated for this well is SHITTIM-1.

This name has a number of important connotations - for both the company and the area.

The name has historical significance as the place where both a new start and a turning point was achieved. This is clearly what is hoped for on North Bruny and for the company. It might also mean a new start for the way in which this state is viewed by petroleum explorers. It is also the name of an attractive tree whose relatives are common in this country and which produces a useful light oil.

Prognosis submitted on behalf of Condor Oil Investments

by C. D. Leaman
Leaman Geophysics 19/11/94

300092

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November 21, 1994

Ms C A Bacon,
Managing Geologist,
Hydrocarbons and Tenements,
Mineral Resources Tasmania,
PO Box 56,
Rosny Park Tas 7018

Dear Ms Bacon,

Mr M Bendall, of Condor Oil, has asked me to prepare a statement about the objectives and needs of his proposed stratigraphic hole "SHITTIM 1" for you.
The following summary essentially restates what was included in my prognosis for this hole. That prognosis was prepared, and the hole specified, on the following bases only.

1. The hole is to be diamond-drilled at core sizes H or equivalent pre collar(near surface) and N (remainder).

2. It is to be drilled for stratigraphic purposes only and to permit geophysical logging and seismic velocity tests.

3. No specific hydrocarbon target is proposed or inferred; nor can any be defined at present.

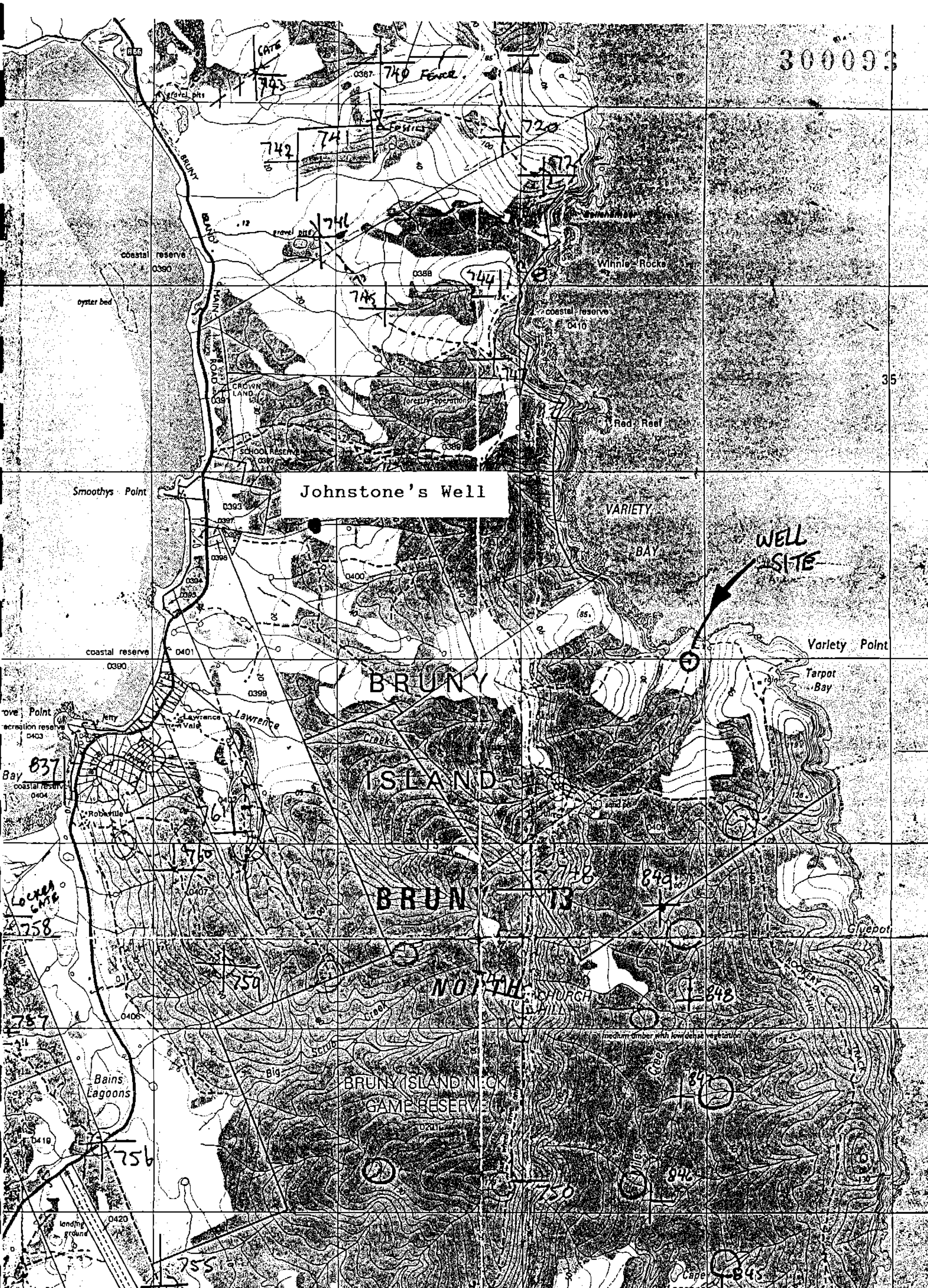
4. There is no expectation that drilling characteristics in this hole, or hydrocarbon encounters, will differ in any material way from comparable stratigraphic holes previously drilled in SE Tasmania.

The prognosis fully discusses these issues.
Any major change, by the company or driller, of hole type (other than of any pre-collar), depth range, drilling method or objective might well change these presumptions. I have indicated to Mr Bendall that I would prefer he avoided the use of a pre-collar since some shallow information might be lost in the subsequent dependence on down hole logging methods near surface. Full chip samples should be retained if a pre-collar is drilled.

Yours faithfully,

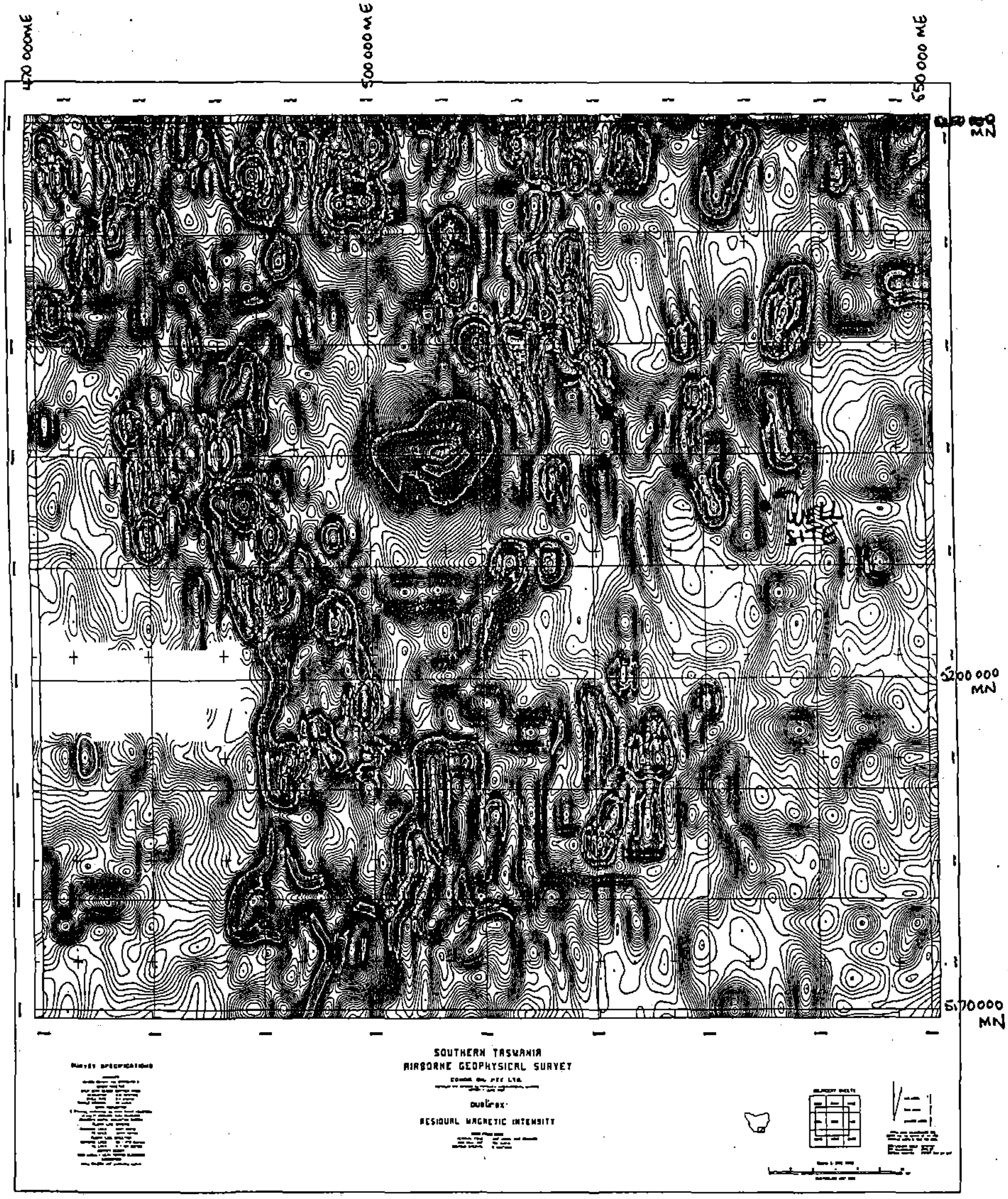
D Leaman

Dr. D.E. Leaman



CONDOR OIL INVESTMENTS - LOCATION OF WELL NORTH BRUNY ISLAND

FIGURE 1

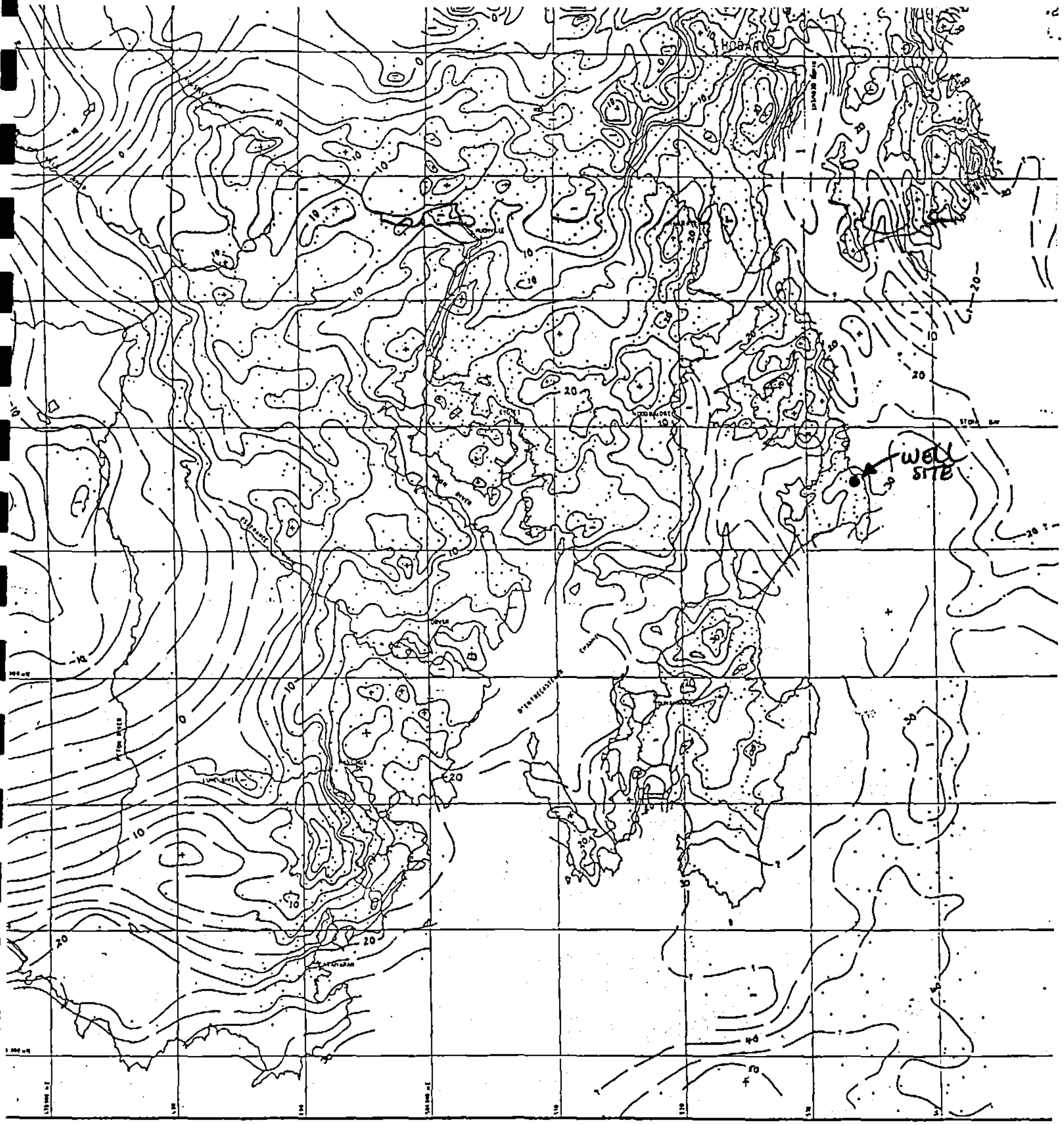


CONDOR OIL INVESTMENTS
FIGURE 2

NORTH BRUNY WELL

COMPILATION MAP: AEROMAGNETIC SURVEY AT 1000 M ASL

(Use transparent geographic overlay to locate positions)



ONGA OIL PTY LTD

PROJECT: D'ENTRECASTEAUX GRAVITY SURVEY

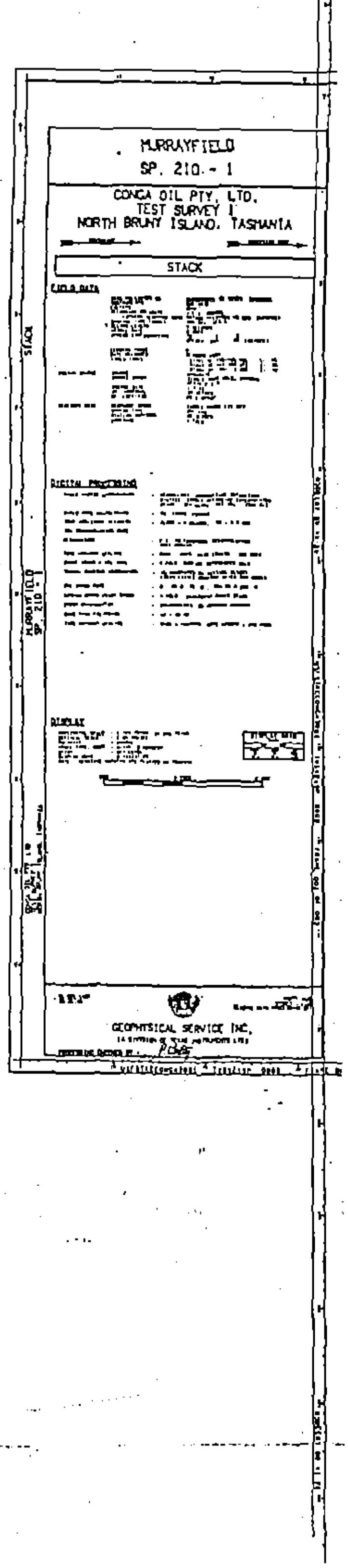
BOUGUER ANOMALY (2.67 t/m³)

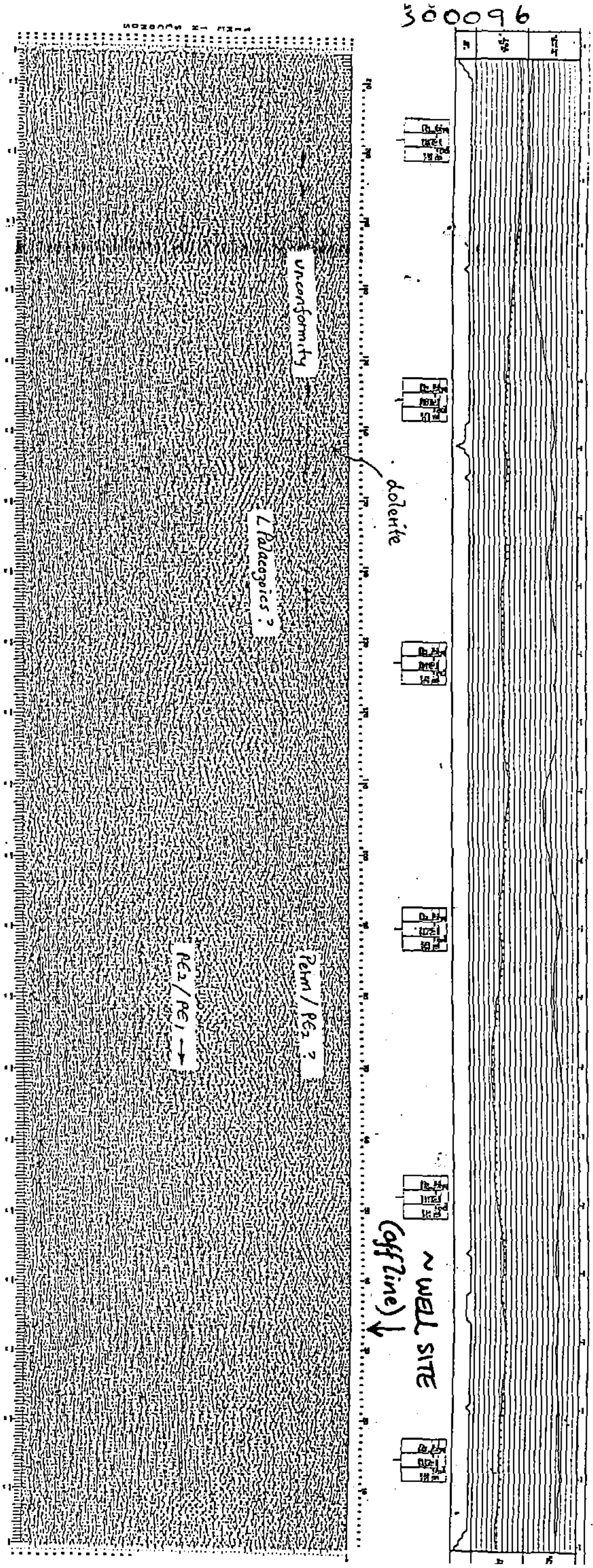
CONTOUR INTERVAL: 2 mgal (5 mgal offshore)

300095

GRAVITY FIELD IN SOUTH EAST TASMANIA

CONDOR OIL INVESTMENTS
FIGURE 3

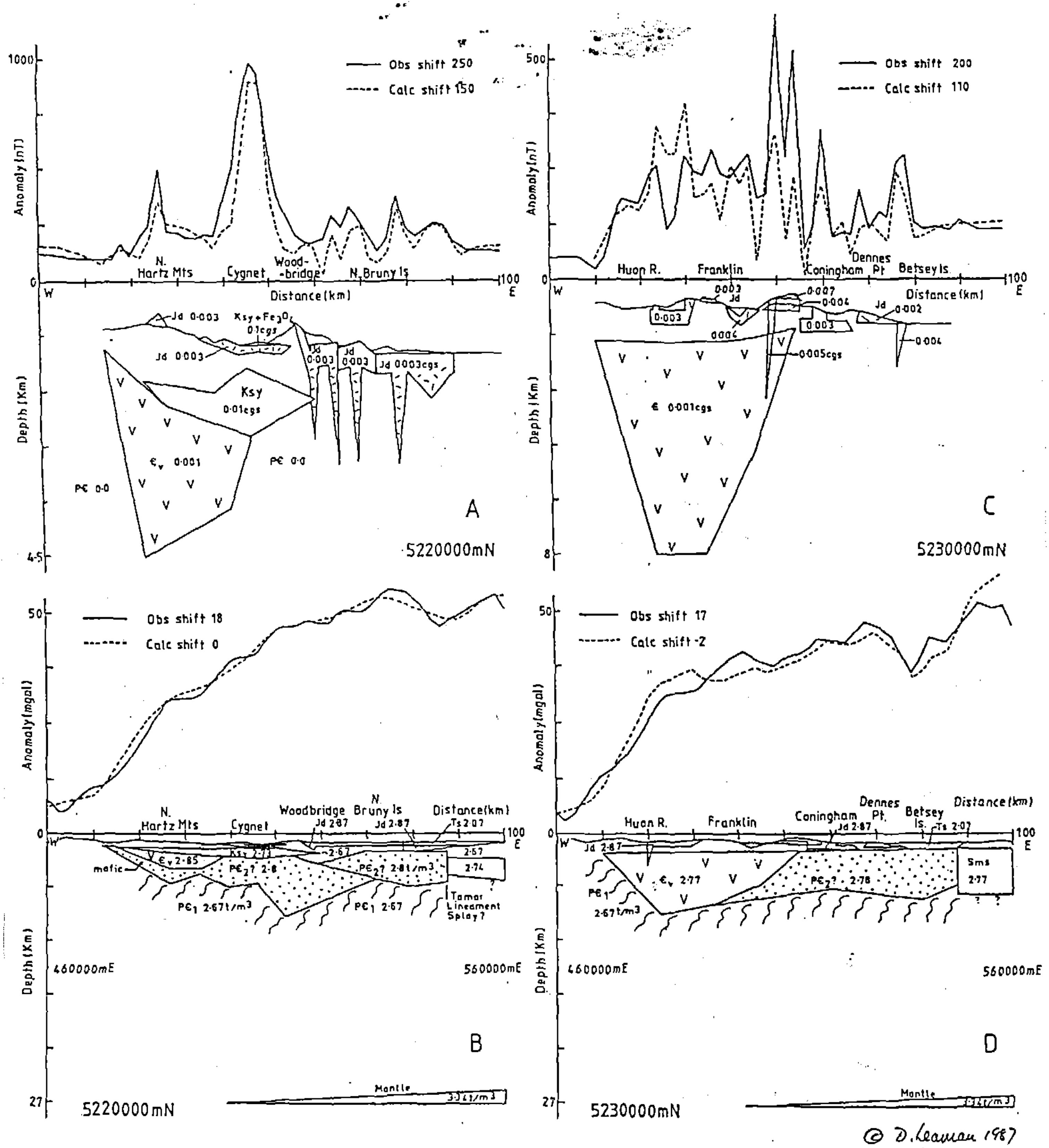




MURRAYFIELD TRAVERSE
NORTH BRUNY ISLAND

CONDOR OIL INVESTMENTS
NORTH BRUNY WELL

FIGURE 4

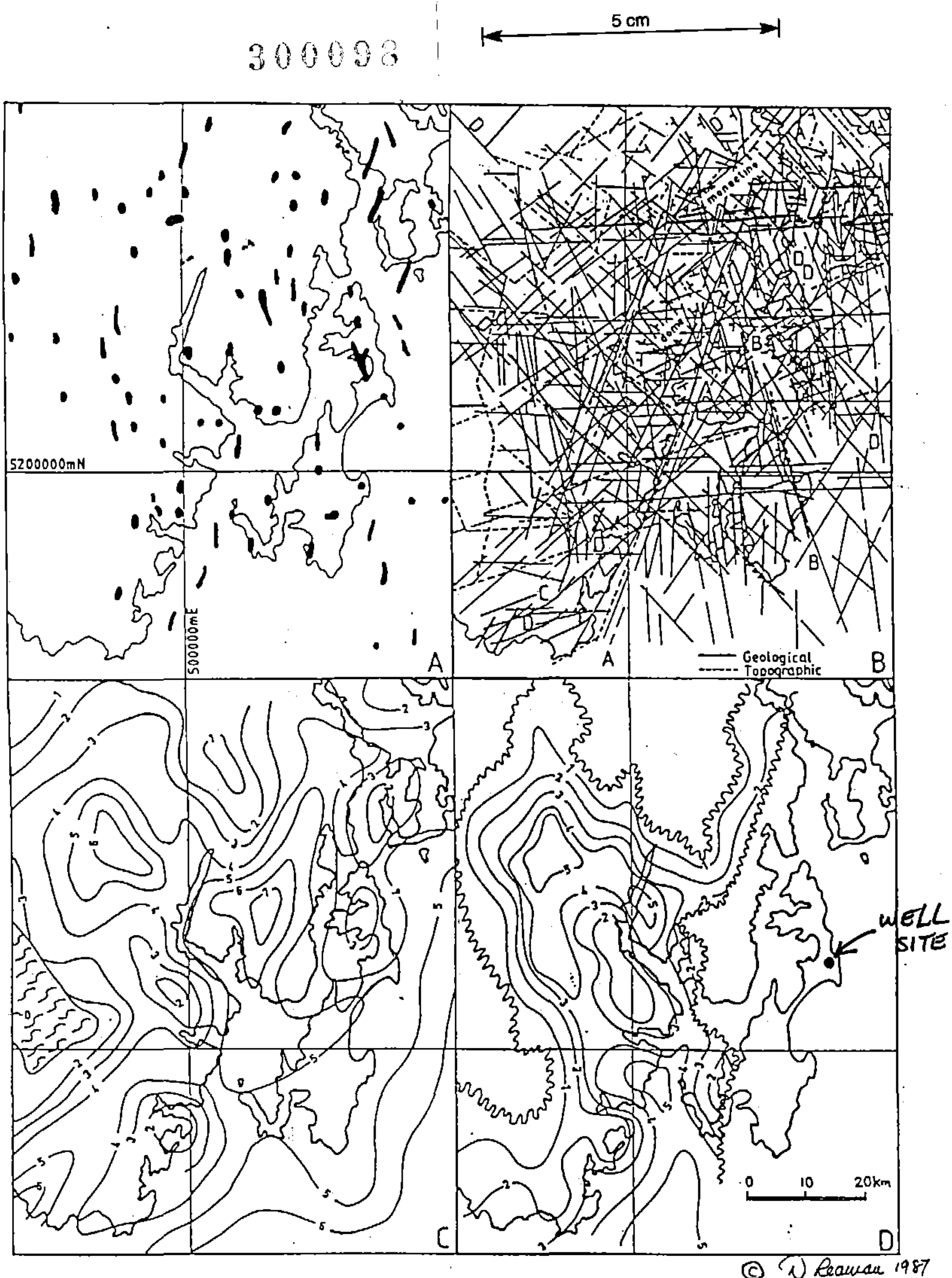


CONDOR OIL INVESTMENTS
INTERPRETED SECTIONS ACROSS BRUNY ISLAND

EXAMPLES OF INTERPRETATION MODELS AND CHARACTER OF MAGNETIC AND GRAVITY FIELDS IN SOUTH EAST TASMANIA

FIGURE 5

300098



CONDOR OIL INVESTMENTS

SUMMARY OF STRUCTURAL INFORMATION DEDUCED FROM GRAVITY AND MAGNETIC DATA IN SOUTH EAST TASMANIA. See also Figures 5B, 5D, 5E.

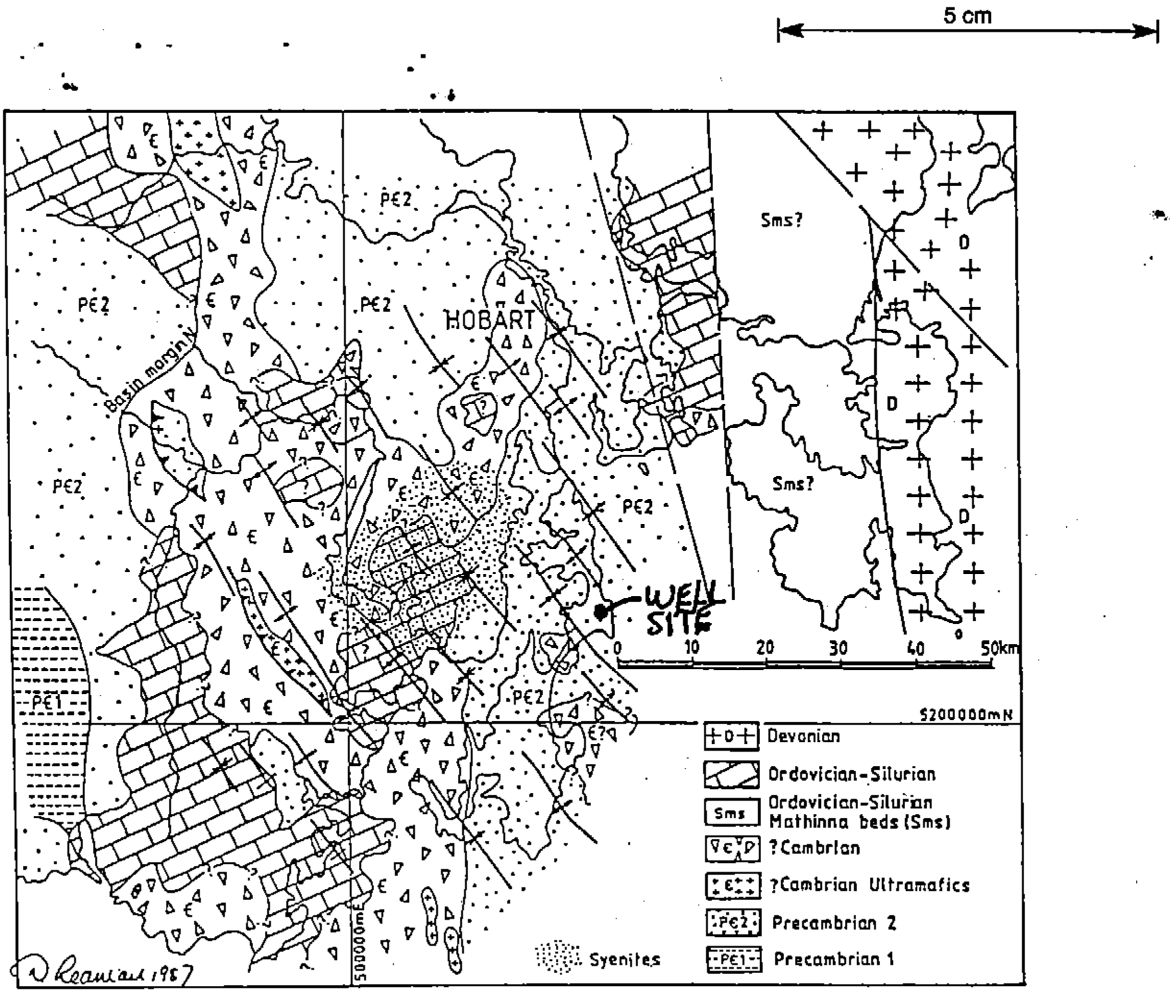
A: Location and orientation of Jurassic dolerite feeders. The pattern is non random and is related to older flexures.

B: Trend summary diagram, all data. Labelled structures exemplify major axes rejuvenated.

C: Contours in km below sea level of depth to crystalline basement.

D: Contours in km below sea level of base of Cambrian (?) units - incl. volcanics. Gap between C and D represents a variable thickness of Late Precambrian dolomitic sequences.

FIGURE 6



NATURE OF GEOLOGY INFERRED BENEATH PERMIAN UNCONFORMITY IN SOUTHERN TASMANIA
(based on initial geophysical interpretations. Provisional)
Note that distribution of Ordovician-Silurian rocks is not yet well defined and will be the subject of second order refined analysis. The indicated fold systems are likewise sketchy at this stage.
Compare this plan with sections and basin structure contours in

CONDOR OIL INVESTMENTS — NORTH BRUNY WELL

FIGURE 7

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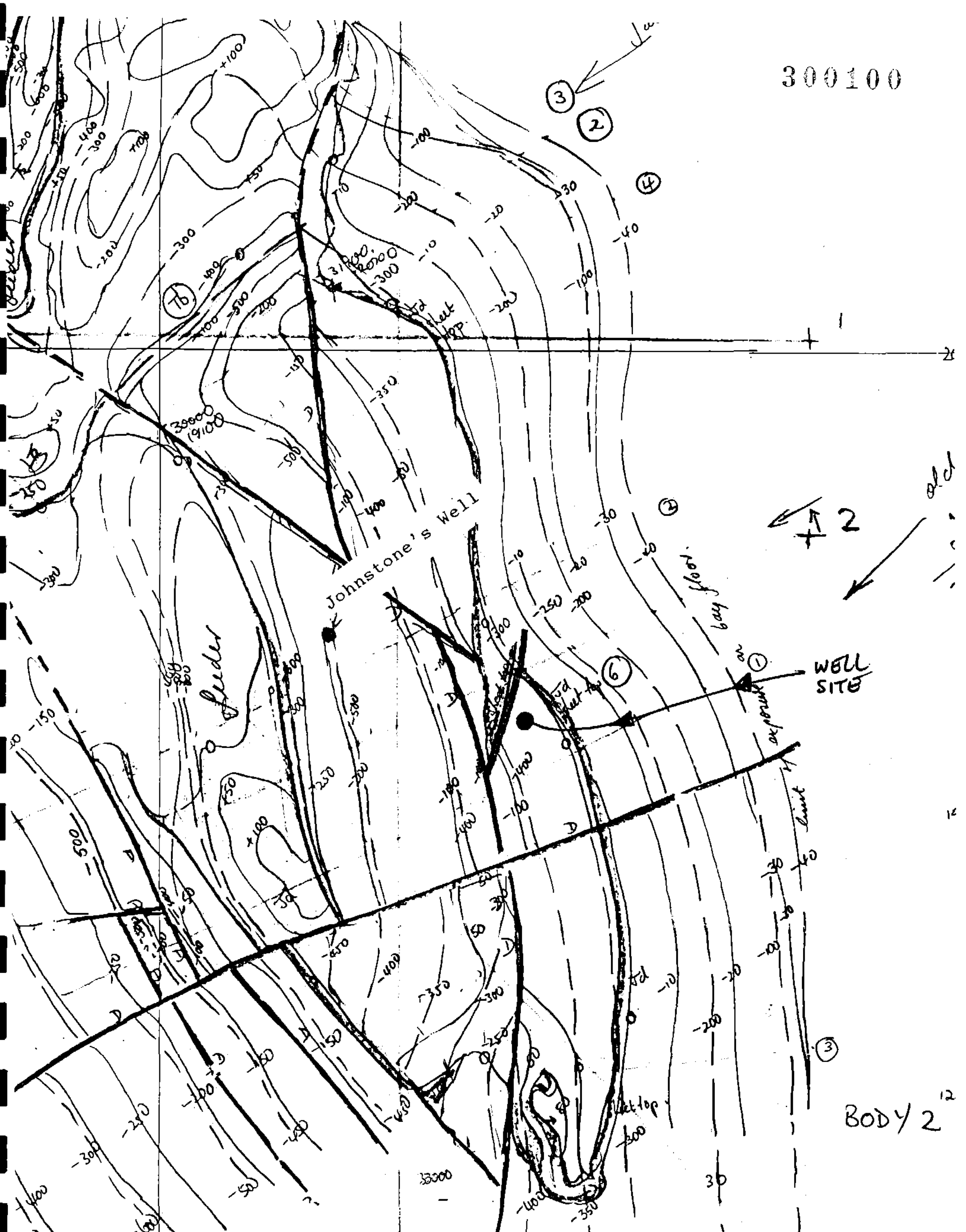
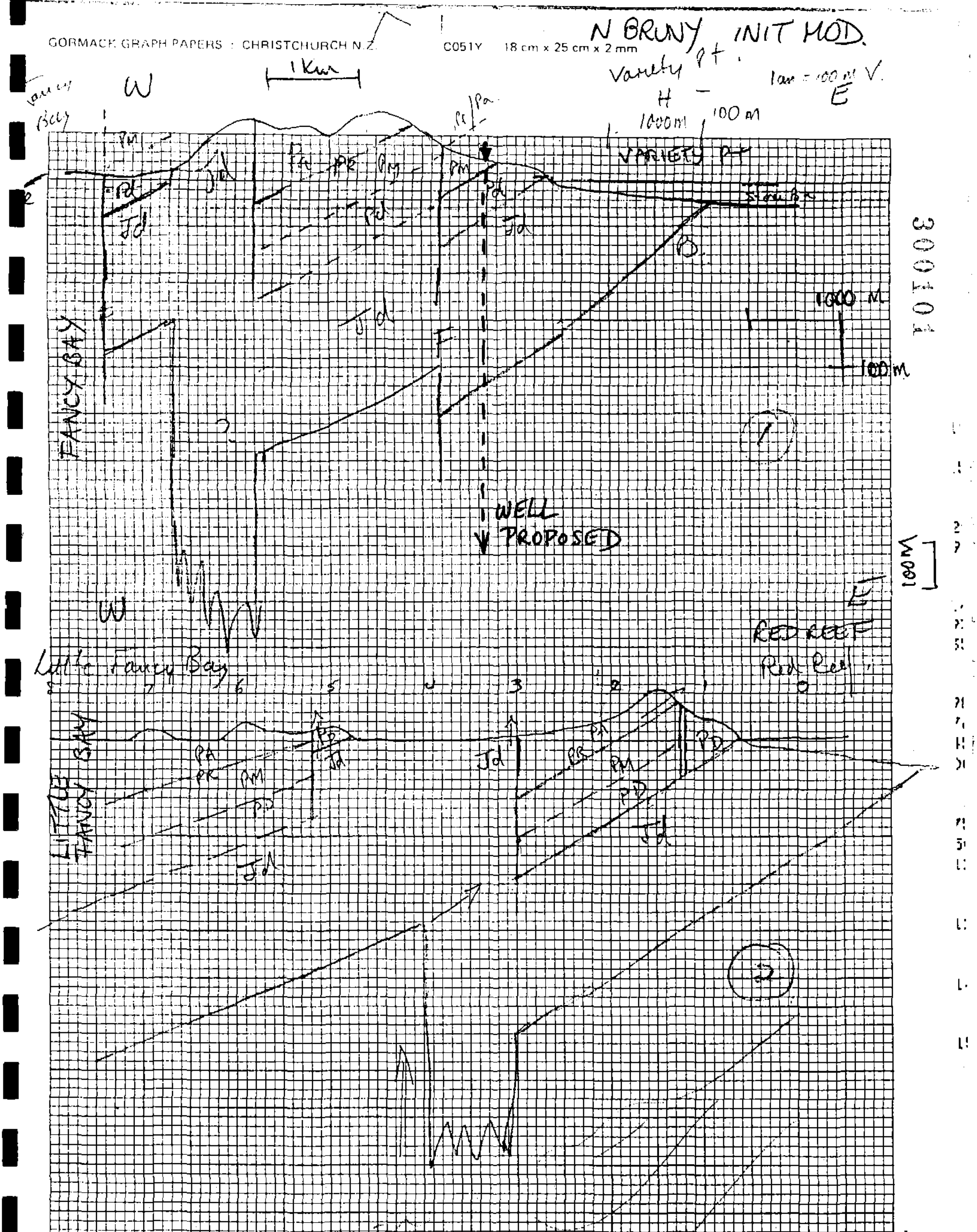


CONDOR OIL INVESTMENTS NORTH BRUNY WELL
SKETCH MAP: PART OF INCOMPLETE 3D INTERPRETATION OF NORTH BRUNY REGION SHOWING LOCATION AND CONTINUITY OF DEEPER FAULTS
Analysis by Leaman Geophysics 1988 FIGURE 8



CONDOR OIL INVESTMENTS NORTH BRUNY WELL
SKETCH SECTIONS: VARIETY BAY AND GREAT BAY REGION
Upper section through well site.
Draft section by Leaman Geophysics 1988 FIGURE 9

Appendix (4) (5)

300102

SHITTIM 1A
STRATIGRAPHIC SLIMHOLE DRILLING PROGRAM

CONTINGENCY WELL PLAN
BLOWOUT PREVENTION AND WELL CONTROL
RIG SAFETY AND EMERGENCY RESPONSE

FOR
CONDOR OIL INVESTMENTS PTY LTD

Prepared by Pectil Engineering
26 Colin Street West Perth Western Australia 6005
Tel (619) 481 3322 Fax (619) 481 3330

Condor.doc/14 December 1994

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Shittim 1A
Contingency Well Plan

CONTENT

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Shittim 1A
Contingency Well plan

WELL LOCATION AND CONTRACTOR COMPANIES

Well Name	Shittim 1A	Shire	
Location	Nth Bruny Island	Coordinates	533 000E 5215 000N
State	Tasmania	Elevation	25m ASL
		Datum	Footclamps
		Rig Make	UDR 1500
Anticipated Spud Date	January 1995	Projected Depth	1,000 m

OPERATOR	CONDOR OIL INVESTMENTS PTY LTD BLACKMANS BAY TASMANIA TEL (002) 296 576, FAX (002) 292 153
COMPANY REPRESENTATIVE	MR MALCOLM BENDALL
DRILLING CONTRACTOR	PONTIL PTY LTD DRILLING CONTRACTORS JANNALI RD DUBBO NSW 2830 TEL (068) 884 2722 FAX (068) 842 697
DRILLING ENGINEERING	PECTIL ENGINEERING SERVICES TEL (09) 481 3322, FAX (09) 481 3330
DRILLING SUPERVISOR	EDWARD C. MCNALLY
GEOLOGICAL SUPERVISOR	DR CLIVE BURRETT
DRILL FLUID ENGINEERING	PECTIL ENGINEERING SERVICES
GEOPHYSICAL LOGGING	WHEN REQUIRED BPB AUSTRALIA
MUD LOGGING	WHEN REQUIRED BY EXLOG
CASING	PONTIL
CEMENTING	PONTIL
SURVEYING	PONTIL
BLOWOUT PREVENTER STACK	PECTIL ENGINEERING SERVICES
PRODUCTION TESTING	WHEN REQUIRED BY HALIBURTON

Shittim 1A
Contingency Well plan

Shittim 1A Well Configuration

	Hole Size	Casing Size	OD (in)	OD (mm)	ID (in)	ID (mm)	Weight (kg/m)
Conductor	8.5"	PW	5.5	139.7	4.94	125.5	23.14
Surface Hole	5.5"	HW	4.5	114.5	4.00	101.4	16.83
Intermediate	3.782"	HQ	3.5"	89.0	3.063	77.8	11.45
Objective Hole	2.98	NQ	2.76	70.0			

Shittim 1A Drilling Program

	Hole Size	Casing Size	Drilling Method	Max Depth	Mud System.	Bit
Conductor	8.5"	PW	Mud Rotary	Consolidation	FW/Gel	Tricone
Surface Hole	4.875"	HW	Mud Rotary	150 m	FW/Gel	Button Tricone
Intermediate	3.782"	HQ	Diamond Core	<450 m	Brine Polymer	Impregnated
Objective Hole	2.98	NQ	Diamond Core	1,000 m	Brine Polymer	Impregnated

Shittim 1A Geological Prognosis

Depth	Formation	Lithology
0 - 20m	Minnie Point Formation	sandstone/siltstone
20 -- 50m	Deep Bay Formation	fossiliferous mudstone
50 - 400m	Dolerite	
400 - 450m	Deep Bay Formation	fossiliferous mudstone
450 - 550m	Bundella Formation	fossiliferous mudstone
550 - 700m	Woody Island Siltstone	mudstone
700 - 1000m	Truro Tillite	tillite
	Unconformity	
>1,000m	Precambrian	schists

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Shittim 1A

Contingency Well plan

UDR 1500 DRILL RIG DESCRIPTION

Drill	Universal 1500 all Hydraulic Top Drive
Mast	16 m length with 12 m rod pull capacity
Power	172 kW GM 6-71N Diesel, 2100 rpm
Rotation Head	Top drive direct couple. High-Low manual gear range 5-380 rpm low range, 380-1500 high range Stepless speed range
Rotation Head Torque	Max 6,800 Nm low range, 360 Nm @ 1,500 rpm high range Fully automatic torque speed control running diamond bits at maximum
General Features	50 mm (2") ID floating hollow spindle, jet lubricated gears and bearings possible rpm using maximum available horsepower Water to oil heat exchanger.
Head Traverse	Hydraulic cylinder over chain with 7.32 m of traverse Max traverse speed 24 m/min up and 18 m/min down Hydraulic head racks back in top mast
Pull Down	7,000 kg
Pull Up	15,000 kg
Water Pump	2 * FMC Bean triplex pumps Rated 140 LPM (36 USG/min), 7,000 kPa (700 psi)
Rod Breakout	Hydraulic Rigid Stillsons 9,500 Nm makeup torque, 12,000 Nm breakout torque
Rod Clamps	44.5 mm (1.75") to 168.3 mm (6.625") in rod clamps with 8.75" clamp opening Hydraulic, self energizing with hammer wrenches and bit baskets
Wireline Winch	2,000 m of 10 mm (3/8") wire rope. 1,800 kg full drum pull at 260 m/min
Hydraulics	Axial and radial piston pumps designed with 3 .independent open loop circuts (Main - Water - Cylinders)

Rig Depth Rating

Drilling Method	Hole Size	Rod Size	Rated Depth	Diamond Core
Air/DHH	127 mm	73 mm	816 m	
Mud rotary	165 mm	89 mm	663 m	
Diamond Core	122.6 mm	117.5 mm	900 m	PQ
	96.0 mm	89 mm	1,200 m	HQ
	75.7 mm	70 mm	1,800 m	NQ
	60.0 mm	56 mm	2,300 m	BQ

Rig Dimensions	Weight	Length	Width	Height
	19,500 kg	16 m	2.5 m	3.6 m

Bare drill on hydraulic jackup tray

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Shittim 1A
Contingency Well plan

DRILLING SCHEDULE AND ESTIMATED EXPENDITURE

Activity	Hours	Cost
Intangible Items		
Rig Mobilisation Dubbo to Bruny Is	(72)	$7,500
Establishment unpack / rig up	(12)	$$2,500
Drill and set conductor pipe	0	
Mud rotary drilling to 150m surface HW casing point.	36	$5,250
Conditioning hole	12	$6,000
Run and cement surface HW casing	18	$4,500
Install and test Blowout Preventer	12	$3,000
Diamond HQ core drill to <450m intermediate casing point.	36	$35,000
Condition hole	36	$9,000
Run and cement intermediate HQ casing	18	$4,500
Install and test Blowout Preventer	6	$1,500
Diamond NQ core drill to Total Depth	165	$57,600
Condition hole	24	$6,000
Surveying	4	$1,000
Cement abandonment plugs	24	$6,000
Disestablishment rig down / packup	(12)	$2,500
Demobilisation Bruny Is. to Dubbo	(72)	$7,500
Miscellaneous Intangibles		$3,000
Tangible Items		
BOP		$6,000
Drill Fluids		$5,546
Casing and Cement		$11,880
Management		
Consultant Drilling Supervisor		$7,500
Consulting Geologist		$3,500
Totals	24 days	$196,696

Anticipated Drilling Rates

Rig Hourly Rate $200 and $250/hour

Drilling Rates

Pre-Collar	**Depth**	**Cost**	**4 7/8"**	**Depth**	**Cost**
	0 - 100m	$24/m	Rotary Drilling	0-100m	$28
	100 -200m	$28/m		100-200m	$30
				200-400m	$35
HQ Coring	0 - 600	$69/m	NQ Coring	0 - 600m	$68/m
	600 - 800m	$90/m		600 - 800 m	$79/m
	800 - 1000 m	$100.m		800 - 1200 m	$90/m
				1200 - 1600 m	*$100/m*

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Shittim 1A
Contingency Well plan

CONTRACTS SUMMARY

Description	Supplier
Location access, site survey and restoration	Condor Oil Investments Pty Ltd
Mobilisation / Demob	Pontil Drilling Contractors
Establishment / Disestablishment	Pontil Drilling Contractors
Water trucking	Hazel Brs. Construction
Water bore and materials	Pontil Drilling Contractors
Well site drilling supervisor	E. C. McNally
Rig Hire	Pontil Drilling Contractors
Wages and on costs	
Camp hire and catering	Hazel Brothers Construction
Fuel & lubricants	Pontil Drilling Contractors
Mud chemicals and engineering	Baroid/AMC (Tasmania)
Communications	Pontil Drilling Contractors
Miscellaneous intangibles	
Cement and chemicals	Readymix
Cementing plant rental	Pontil Drilling Contractors
PW, HW & HQ Casing and casing handling	Pontil Drilling Contractors
Casing tooling	Pontil Drilling Contractors
DST tool rental	Lynes as required
Core equipment	Pontil Drilling Contractors
Core handling and core analysis	
Portable cellar	Pectil Engineering
Blowout preventer equipment rental	Pectil Engineering
Kill and test pump	Pontil Drilling Contractors
HW well flange	Pectil Engineering
Downhole drill and casing tooling	Pontil Drilling Contractors
Ancillary surface mud handling equipment rental	Pontil Drilling Contractors
Ancillary mud surface equipment	
Mud logging	Exlog Gas Detector
Geophysical wireline logging	BPB Australia as required
Materials transport	Hazel Brothers Construction
Personnel transport	Hazel Brothers Construction
Rig Insurance	Pontil Drilling Contractors
Well overheads (3%)	Pontil Drilling Contractors
Well Insurance	Condor Oil Investments Pty Ltd
Office and administration	Condor Oil Investments Pty Ltd

Shittim 1A
Contingency Well plan

DRILLING PROGRAM

Introduction to Wireline Diamond Core Drilling Practice
Wireline retrieval coring is integral to most stratigraphic drilling programs and frequently proceeds after setting and cementing the surface casing to the end of hole.

The wireline retrieval system permits core to be recovered while drilling without the necessity for tripping the drill string. This recovery system had its origins in the oil field where it was first developed to recover core inside the drill pipe. Core could be recovered on the drill floor without the time consuming and costly operation of tripping the drill string.

Later the Longyear Company in the USA further refined this tooling for the mineral drilling industry. Wireline retrieval tooling they developed is designated by the letter Q when describing the size of a hole. The common sizes used for slimhole drilling are BQ, NQ, HQ and PQ (see Table 3D & Table D4 of the Appendices). More recently this company has developed a line of heavy duty wireline tooling for use in three hole sizes. The tooling sizes are designated CHD 76, CHD 101 and CHD 134.

The priority for formation data collection is placed on core analysis techniques and is not restricted to the mud logging of drill cuttings or wireline geophysical log interpretation.

Geological stratigraphic evaluation may be more useful to development of the understanding of hydrocarbon resources of a permit at an early stage of exploration and oil companies may wish to use coring to determine reservoir, source, biostratigraphic, petrographic, stratigraphic and structural studies.

In circumstances where seismic exploration is being planned a core drilling program may be useful assisting subsurface control

Slimhole core drilling operations for oil and gas exploration are being increasingly applied for wildcat exploration in Europe, Canada, America, Asia and Australia and it is usual for 90% of a well is recovered as core. Using conventional oil drill rigs for this work would be prohibitively expensive.

In Australia Western Mining Corp in the central Canning Basin of Western Australia, CRA-Pacific Oil & Gas in the McArthur and Gorgina Basins of the Northern Territory and Shell Company of Australia in Queensland have all conducted slimhole continuous coring exploration drilling programs in recent years. mThe uphole and objective intervals in these areas were all cored and 90% successful recovery was achieved.

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Shittim 1A
Contingency Well plan

DRILLING OPERATIONS PROCEDURES

Precollar Hole
Drill 8 1/2" hole on HW drill rods to indurated depth
Set and cement PVC precollar casing.

HW Drilling
Pick up 5 1/2" tricone bit on HW rod string
Drill 5 1/2" hole to HW casing point.
If dolerite is hard drill to reliable HW casing point with diamond core assembly
Run and Cement HW casing
Make up HW BOP and pressure test to schedule

HQ Coring
Make up HQ core barrel assembly to drill 3 7/8" hole to
Run in hole and tag top cement plug
Core drill cement plug and cement in the rat hole.
Core drill to HQ casing point.
Make up Run and cement HQ casing string

NQ Coring
Make up well BOP assembly for NQ rods and run pressure test schedule
Make up NQ core barrell assembly to core drill from HQ casing shoe
Run in hole and tag cement plug
Core drill cement plug and cement in rat hole
Core drill to end of hole

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Shittim 1A
Contingency Well plan

DRILL FLUIDS PROGRAM

Introduction
Contractors charge operators for mud consumables landed at the location and are responsible for the design of the mud system and its maintenance. Coring muds are normally built using polymers to increase viscosity and hole cleaning properties of the mud. The contingency program below describes the use of weighted muds that may need to be used in the event that abnormal pressure is encountered while drilling the HQ or NQ hole. A mud scales and Marsh funnel will be supplied by the supply company.

Precollar Hole
Drilled 8 1/2" using water

HW Drilling
Fill three mud tanks with fresh water and treat out hardness with caustic soda and soda ash
Make up fresh water gel mud. Bring the viscosity to 60 sec with Pac polymer

Weight up tanks 1 and 2 with barytes. Bring the weight to 1.5 SG

Pick up 5 1/2" tricone bit on HW rod string. Displace mud via the hole while drilling from mud tank 3. Continue to build mud in tank 3. as the drilling proceeds.

If the well is pressured displace the hole using the weighted mud in tanks 1 and 2.

Maintain the mud density below 1.1 SG and maintain a viscosity from 36 to 40 sec.
Condition pit mud in tank 3 while drilling.

Run desander/desilter from suction sump pit as required

HQ Coring
Discard HW drilling mud in the mud pits.

Maintain tanks 1 and 2 with weighted drilling mud while HQ coring.

Make up the brine tank with water and saturate with salt. Circulate the tank with the Gardner Denver Pump to achieve saturation. Maintain the saturated brine for use to displace the hole while HQ coring.

Core drill out of the cement shoe using water
Make up tank 3 with fresh water, treat out hardness and build polymer mud. Build viscosity from 36 to 40 sec and displace to the hole while core drilling in new formation. Continue to build mud in tank 3 as drilling proceeds.

Maintain the mud density below 1.1 SG and maintain a viscosity from 36 to 40 sec.
Condition pit mud in tank 3 while drilling. If underbalanced transfer the brine to the hole and continue to build a brine polymer drill fluid in tank 3. Continue to saturate the make up water in the brine tank while circulating with the Gardner Denver pump.

To control pressure displace the weighted mud in tanks 1 and 2 to the hole

Run desander/desilter from suction sump pit as required

NQ Coring
Continue to build and run the mud as for HQ core drilling procedures

Shittim 1A
Contingency Well plan

DRILL FLUIDS PROGRAM

Materials Inventory

Chemicals	Unit	Cost	Quantity
Weight Agent			
Barytes	2000kg		
Salt			
Calcium Chloride			
Viscosifier			
Gel	25kg	$648	1,200kg
Quick mud	250kg (drum)		
(liquid polyaclyamide)			
Deflocculants			
QBroxin			
QB2			
Invirothin	50 lb	$270	250 lb
Visco-Filtration Agent			
AquaPac	50 lb	$3,960	1,000 lb
Pac-R			
(cross linked polymer)			
XC Polymer			
Inorganic Agents			
Magnesium Oxide	25kg	$342	100kg
Caustic Soda	25kg	$198	100kg
Soda Ash	25kg	$128	100kg
Bicarbonate	50kg		
Total Cost		$5,546	

Supply
Baroid Australia Contact Gus Van der Hyde Tel (03) 621 3311
AMC Contact John Quale Tel (09) 417 5001

Surface Plant

Mud Tanks
3 x 2,000 litre mud tanks
1 x 2,000 litre brine and cement tank
1 x 2,000 litre suction ground sump
1 x 2,000 litre discharge ground sump

Desander

3 x 3" centrifical mix pumps
mud hopper

2 x FMC 36 Bean rig mud pumps rated 1,200 psi
1 x FMC 60 Bean kill pump rated 1,500 psi
NPT Mudline manifold

1 x 5 x 6 Gardner Denver Duplex Pump
(3" Liners, rated to 1120 psi @ 400 rpm)

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Shittim 1A
Contingency Well plan

CASING & CEMENTING

The well casing plan is shown on page 4 of this report. The published dimensions and physical properties of the drill rods and casing used are described in Table D3 and D4 of the Appendices. A casing design program to consider the physical yield, collapse and burst properties of the rods and casing would not usefully develop the program.

A cementing program has been prepared using Class A cement properties tabled in "Drilling Data Handbook" 1978 Editions Technip.

No program for the abondonment of the well is included at this time.

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Shittim 1A
Contingency Well plan

CASING AND CEMENTING

Materials Inventory

Cementing Unit
Gardner Denver 5x6 with 3" liners
Rated 1120 psi @ 400 rpm displacing 183 US gal/min

				Cost
Cementing Materials				
HW Casing Cement	30 Sacks Class A cement			$180
HQ Casing Cement	45 Sacks Class A cement			$270
Cement Additives				$50
Abondonment Cement Plug				
Bottom Plug	Sacks Class A cement		$5.95/sack	$
Casing Shoe Plug	Sacks Class A cement		$5.95/sack	$
Top Plug	Sacks Class A cement		$5.95/sack	$
Casing Materials				
PVC Conductor Pipe		6m	$20	$120
HW Casing Rods		150m	$32/m	$6,400
HQ Casing Rods		<450m	$28/m	$12,600
(HQ Recovered)		(400m)	$20/m	<$8,000>
HW Casing shoe (optional)				
HQ Casing shoe (optional)				
HW Van Ruth Cement Wiper Plug				$30
HQ Van Ruth Cement Wiper Plug				$30
HW Van Ruth non return valve				$100
HQ Van Ruth non return valve				$100
	Total Cost			$11,880

Note
Cost of cementing abandonment plugs has not been determined.

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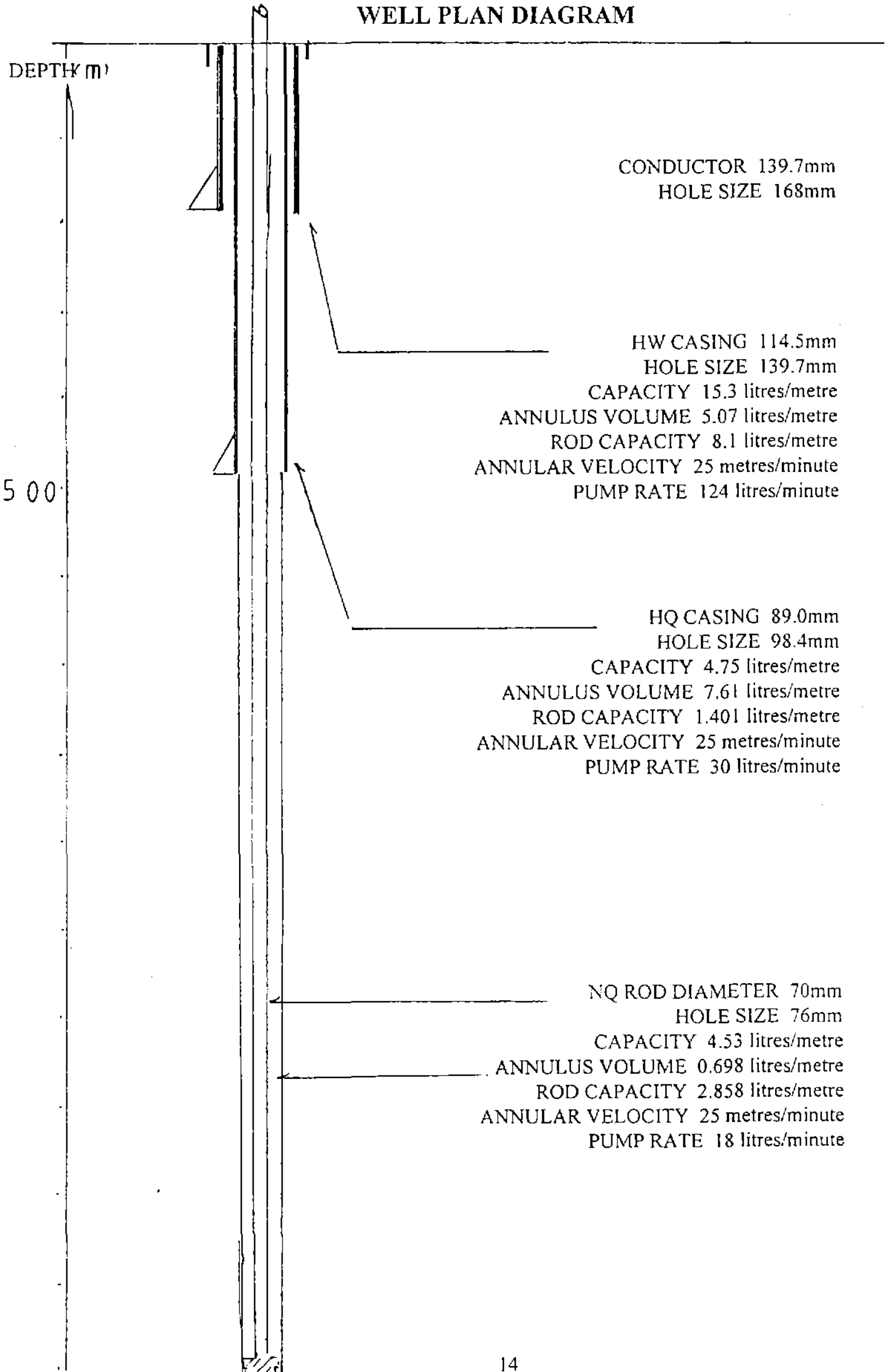
Shittim 1A
Contingency Well plan

WELL PLAN DIAGRAM



BLOWOUT PREVENTION AND WELL CONTROL

The theoretical accumulated volume displacement should be compared through a trip with actual accumulated volumes that are returned to or from the well as the drill string is withdrawn or run back in the hole. When the hole is not taking the correct volume this should alert the driller that invading fluid may be flowing into the well bore.

Pump stroke counts and measuring the pit volume all assist the driller to calculate and confirm that the volumes to replace the displacement are correct.

An oil saver-wire line stripper connected to the top drill rod recovers mud from a travelling wire line and provides blow out protection when retrieving the inner core tube however this operation is carried out with flow check procedures outlined in the section Flow Checks for Core Drilling.

In some areas during tricone rotary drilling, it may become useful practice to slug the pipe with a barite plug before commencing to trip out of the hole. This will assist in stabilizing the hole when the drill string is at the surface.

Swabbing:
Swab pressure is created while pulling the drill string or inner core barrel from the hole. Suction arises, since mud does not re-enter the hole as fast as it is displaced. Where hydrostatic pressure of a mud column is only slightly above the formation pressure, the resulting pressure loss from swabbing may allow formation fluids to flow into the well. The pressure reduction from swabbing is a function of hoisting speed, clearance between the well bore and the drill string, mud properties and bit water course size.

The most critical period of influence from swabbing will occur while pulling the first few stands of the drill string off bottom. A check to ensure that formation fluid is not being swabbed into the hole at the early stages of a trip will often be advisable.

Lost Circulation:
The are numerous causes for lost circulation which may frequently arise in shallow un-consolidated beds and in deeper rocks which may fracture because the hydrostatic pressure exerted by the mud column exceeds the fracture pressure of a formation or because a formation is naturally fractured or cavernous.

When the hydrostatic pressure in the well bore exceeds the fracture pressure of the formation, the formation will break down and mud will be lost to that zone. Lost circulation is particularly hazardous when zones with pressure higher than the hydrostatic pressure of the mud column which stabilises after the losses become exposed and push fluids into the well.

Frequently circulated returns are lost and the fluid level will stabilize at some point down hole where the hydrostatic pressure balances the formation pressure in the lost circulation zone. On other occasions only partial losses are experienced to a zone and circulation may be restored after treatment to plug the formation.

If lost circulation occurs while a kick is being handled with pressure on the preventors, an underground blowout may occur. The zone of lost circulation must then be repaired before normal well control procedures are carried out. Sometimes it is possible to spot a heavy slug of high density mud below the thief zone in the zone of high pressure and this effect repairs to the zone of lost circulation.

On other occasions it will become necessary to repair the thief zone with a thixiotropic cement squeeze and possibly then case out the two zones after drilling to a suitable formation in which the casing can be secured.

BLOWOUT PREVENTION AND WELL CONTROL

Abnormal Over-pressure:
As stated abnormal over-pressured formations are frequently defined as those formations with a pressure gradient in excess of a normal column of sea water. This normal formation pressure gradient is 0.1073 kgf/cm^2 / metre.

If an high pressured formation is penetrated with insufficient mud density, then a kick situation is likely to develop. The response will usually depend on wether the permeability and porosity in the formation is sufficient to permit fluids to flow freely from the highly pressured formation into the well bore.

Under other conditions a formation may be pressured because compaction in the rock cannot sustain the overburden and although porosity and permeability are not sufficient to allow the escape of large quantities of fluid into the well bore, there may be deformation and accelerated erosion to the well bore. Increasing the mud weight will often prevent or reduce the sloughing and caving of sediments in these formations.

Equipment Failure:
Failure to correctly test, maintain and operate equipment on the rig has in the past been a cause for concern in the industry and has been the reason for loss of life and property in times of blowout. The schedules for function testing surface well head and mud line equipment, the necessity for reporting testing to statutory authorities and training programmes for rig personnel have all assisted in reducing the problem but extra care needs to be given to required operational training in the use of this equipment.

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BLOWOUT PREVENTION AND WELL CONTROL

Introduction to Pressure Control Engineering

Necessary rapid response to emergency situations may best be accorded when drilling crews are trained to react instinctively to implement actions which effectively prevents a situation from becoming unmanageable.

Where practical a well plan should identify those intervals in the well which have a history of abnormal formation pressure manifested either as lost circulation, as highly compacted and sloughing sediments or as highly pressured fluids which may cause a problem to the normal drilling activities undertaken. The investigation should seek to anticipate such problems for well intervals and so assist in designing casing strings as well as drilling procedures to provide the drilling programme, economy and safety in operations.

Supervisors need to provide regular crew drills to enact these procedures so each person on a location is fully practised as to his responsibilities and actions during such an emergency. Drilling crews are reminded that first response is most often a responsibility of the Contract Drilling Company performing operations at the site and that in the normal course of drilling the contractor's personnel will carry on all operations to secure well control.

The first responsibility of a rig crew in an emergency is to preserve personnel at the site from injury or loss of life. The consideration, that the most common cause for loss of life and property on oil an gas drilling rigs in the past has resulted from human error and not through equipment failure, should indicate the importance for carrying on regular drills in safety training on a location.

Our priority is to educate crews in understanding the principles, procedures and specification of equipment employed for safe handling of an emergency response as well as the necessity for communicating all appropriate details through correctly identified channels. Communication procedures for crews are those which have been identified with the operating company representative at the site during the course of a contract drilling programme.

The following section, 'Abnormal Formation Pressure', identifies the origins and indications for abnormal borehole pressure, causes for loss of control in a well bore when encountering abnormal pressure and procedures for carrying out flow checks to detect a kicking well.

Thereafter, 'Well Control Procedures', for handling HW/HQ/NQ rod strings are described

Well Kill Methods which include the 'Driller's Method' and the 'Wait and Weight Method' to shut in and kill the well to prevent a blowout.

Origins of Abnormal Formation Pressure

Formation pore pressure has often been classified as normal where it is equivalent to a normal sea water gradient of 0.1073 kgf/cm^2 / metre and subnormal when less than this. Abnormal over-pressured formations may be in excess of 0.2353 kgf/cm^2 / metre in some sedimentary basins of the world. In such extreme cases the over-pressure arises out of a condition in which formation pore fluids are supporting part or all of the rock overburden. The reasons for this condition are not always fully understood but most explanations argue that incomplete diagenetic compaction during burial of the sediments or geo-tectonic pressuring after compaction and burial is responsible.

Indications of Abnormal Formation Pressure

There are a number of seismic and wireline methods for predicting abnormal pressure in formations which may be employed when planning a well and there are a series of well documented indicators for the onset of abnormal pressure that may be observed when drilling a well. A number of warning signs can be observed at the surface when drilling which will indicate the onset of a kick. It is the responsibility of crew members to recognize these warning signs and act correctly and promptly to recover such a situation.

Early indicators are listed as follows-

1. an increase in the pit volume
2. a sudden increase in the drilling rate
3. an abrupt increase in bit torque
4. a reduction in pump pressure

BLOWOUT PREVENTION AND WELL CONTROL

5. an apparent increase in drill string weight
6. complete or partial loss of circulation
7. decreasing shale density

Secondary indicators which may forewarn of a kick include contamination of the drilling fluid by;.

gas cut
water cut
variation in mud chlorides indicating water cut above
increasing mud temperature
increasing trip gas and connection gas

Causes of Loss of Control of Abnormal Pressure

Kicks, lost circulation or blowouts may occur where formation pressure in the formation drilled is higher than or less than the hydrostatic pressure of the drilling fluid in the well bore. Such an imbalance may permit formation fluids to invade the well and produce a kick at the surface which may develop into a blowout of the well. In circumstances where the formation pressure is less than hydrostatic pressure an under-balanced condition exists and if porous or cavernous rock is being drilled, fluid may be lost to the formation. The loss of hydrostatic pressure arising out of this condition may permit the escape of formation fluids from higher formations into the well bore and similarly cause a well kick or blowout.

Present drilling practice requires maintaining near balanced mud densities and at the same time ensuring hydrostatic pressure is sufficient to control formation pressure. A rule of thumb often employed has been to control mud density to that required for balancing formation pressure plus enough weight to provide for the trip margin.

Australian land drilling operations are frequently complicated where formation pressures will not support the hydrostatic pressure exerted by a drilling fluid and partial or total loss of returns occurs in porous or cavernous surface and intermediate hole.

Less frequently, and often together with a lost circulation event, complications to drilling operations arise through formation pressure exceeding the mud hydrostatic pressure in a well. The causes for kicks are listed below;

1. insufficient mud density
2. failure to keep the hole full of fluid
3. swabbing
4. lost circulation
5. abnormal Over-pressure
6. equipment failure

Insufficient Mud Density:

The condition may occur when drilling into a zone with a drilling mud that is providing less hydrostatic pressure than the formation fluid. Where the formation is permeable, fluids will flow into the well bore. The fluids (gas or water and hydrocarbons) will cut the density of the drilling fluid and compound the condition. Increasing the density for control will not always be a satisfactory remedy since high mud densities may exceed formation fracture gradients and cause lost circulation. Excessive mud densities reduce penetration rates and can lead to the differential sticking of the drill rods and they can damage zones for investigation.

Failure to Keep the Hole Full of Fluid:

Most blowouts recorded have occurred during the pulling of pipe from the hole. Blowouts have resulted through not filling the hole with sufficient mud to replace the drill string volume that is withdrawn from the hole. The influence of swabbing while tripping together with the reduction of hydrostatic pressure from incorrect filling of the hole is the most common cause for rig misfortune and tragedy. The situation is avoided through care to make sure that the correct volume of fluid is being returned to the well after pulling a set quantity of pipe.
Tripping practice to change a bit should include the correct handling of a trip sheet and this should be signed and maintained with drilling tour reports.

BLOWOUT PREVENTION AND WELL CONTROL

The Shittim 1A drilling program is to include the use of blowout prevention equipment. This blowout prevention and control program has been included in the well fore program as a contingency in the event abnormal over-pressure is encountered downhole.

This Blowout Prevention and Control Program has been prepared from Part 5 of Pectil Engineering's Slimhole Drilling Technology Manual. The manual describes manifestations of well pressure and sets the procedures to be followed by crews working for an operating company to control this pressure safely using previously tested blow out control methods.

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SHITTIM 1A
BLOWOUT PREVENTION AND WELL CONTROL

CONTENT

BLOWOUT PREVENTION AND WELL CONTROL

Introduction to Abnormal Pressure Detection
The drillers and drilling crews are instructed to recognise and report any signs indicating the onset of abnormal pressure or those conditions indicating that the well is flowing. The crews are drilled regularly to make flow checks and shut in the well when necessary.

Flow Check Procedure
In order that drilling crews take all necessary precautions to prevent a kick situation arising, it is recommended that flow checks are carried out at specific times during drilling operations.

1. while drilling and in the event of indication of a kick
2. prior to tripping the drill string
3. in circumstances of indication of a kick while tripping
4. while out of the hole
5. while retrieving core

Rapid closing of the well is necessary if excessive surface pressure is to be avoided. Unnecessary and improper closing in procedures can however cause equipment damage and hole problems.
When one or more indicators that a well is kicking are recorded, a flow check should be conducted immediately to confirm the presence of formation fluids entering the well bore. The following procedures are observed.

1. While Drilling:
call alert
stop rotary, then hoist to position tool joint at surface
shut off pump
divert flow to record flow rate and volume
record flow volume for 5 - 10 minutes

2. Before Tripping the Drill String:
call alert
position tool joint above the slip area
divert the flow line to record flow rate and volume
record the flow volume for 5 to 10 minutes
if no flow is noted, trip out of the hole
if the well is flowing, shut it in immediately

3. While Tripping the Drill String:
call alert
position the tool joint above the slip area
install stabbing valve in open position then close
ensure the hole is full
shut down pump
divert flow to record flow rate and volume
monitor the trip tank for flow for 5 to 10 mins

5. While Out of the Hole:
call alert.
ensure the hole is full then shut down pump.
divert flow to record flow rate and volume
monitor the flow for 5 to 10 mins.
continue to monitor the flow each half hour.

6. While Retrieving Core:
The well flow check procedures are those established for carrying on wireline operations in conventional drill string assemblies.
call alert
shut in the wireline oilsaver packer stripper
monitor the flow for 5 to 10 mins. via by-pass
ensure the well has stabilized before completing the flow check

BLOWOUT PREVENTION AND WELL CONTROL

Introduction to Abnormal Pressure Control
General to the procedures for well control and well kill operations in HW/HQ/NQ core drilling are those features of the drill rig and system controls which permit safe handling when drilling in over pressured formations.

Drillfluids suppliers have mud weighting materials compatible for use with wireline core drilling tooling and weighted mud systems are now regularly provided for slimhole operations. Baroid Australia in Victoria and AMC in Tasmania are to supply mud chemicals for drilling Shittim 1A.

Wireline coring drill holes are considerably downsized to conventional oil and gas holes. The surface mud volumes used and pump circulation rates to drill these wells are also much reduced. Fewer, smaller drill cuttings are produced while coring which reduces formation contamination of the drill fluid. A driller works above the hole and can monitor all aspects of the circulating system from his position at the rig consul

It is critical to operations that drill fluid rheological properties and particularly yield and gel strengths are readily controlled to maintain optimum conditions for pressure control management in these wells. The annular mud volumes in core hole geometries are only about 15% of those in conventional oil and gas wells while the circulation system is only about a third of that used by conventional oil field rigs. In these circumstances less time and fewer mud material are necessary build weight, condition the mud and control a kick.

While all other response times may be considered equal, the opportunity for detection of a more exact and smaller variation in pit volume is possible in these circumstances. Attention to this opportunity can provide a lead time for response in such an event.

While wireline coring tools are lighter than conventional rotary drill strings it may be pointed out that in a closed well situation with a HQ core drilling assembly in 4.33" hole locked in under a top drive UDR rig, in excess of 3,000 psi could be contained. This is with out the necessity of closing a shear ram. By comparison, the same situation in a 7 3/4" production hole with a fluted kelly, would require 132,000 lb of string weight to prevent drill pipe from moving up the hole.

While tripping rods, it should also be noted that in spite of these rods having a large bore and a narrow bit kerf area, the calculated resistance to flow (and its resultant implication for swabbing) when pulling a rotary tricone roller bit string will be found to be greater than in the case of the core string.

Wireline core retrieval has no unique feature which characterises the operation from other wireline activities in conventional drilling practice. Two adopted procedures are designed to prevent accident when pulling core;

> a wireline Oil-saver packer stripper, rated to anticipated pressure control requirements (1,500 psi in this manual), is installed on top of the drill rod string. In the event of a kick, the packer may be closed. In this event the core inner barrel becomes suspended in a pressured chamber.
> mud which is allowed to rise while retrieving the core inner barrel is directed back into the hole via a fast acting mud by-pass valve in the drill string. This valve is also shut in the event of a kick.
> when stable, read the shut in casing and shut in drill pipe pressures and record the volume gain

Equipment Rated Pressure:
Well data calculated for carrying out well kill procedures uses rated working specifications for the pressure control equipment and recommended property specifications for the drilling fluids employed. The rated shut in pressure of the Blowout Preventer Well Head is 3,000 psi. The rated pressure of the Annular Blowout Preventer is 1,000 psi. The operating pressure of the Blowout Preventers is 750 psi. An equipment list and diagrams for the BOP equipment are shown in the Appendices.

Friction Pressure Loss in the Circulating System:
The following procedures programme identifies the fundamental concern for the handling of friction pressure losses in these geometries when planning to control and kill a kick.

BLOWOUT PREVENTION AND WELL CONTROL

Pumping to Displace Mud in the Drill String:
Displacement is effected by pumping new mud at the controlled slow pump stroke rate and maintaining choke adjustment to control the pump pressure. This is the Initial Circulating Pressure at the commencement and is reduced to the Final Circulating Pressure when the new mud reaches the bit.

While making this choke correction it can be seen that pump strokes may increase as the pump pressure falls and to return the well to balance it is necessary to close the choke until pressure and pump rate return to their designated values. Should the pump pressure increase and the pump stroke rate begin to fall, then it is necessary to gradually open the choke to restore balance.

Pumping to Displace Mud in the Annulus:
When pumping to displace the annulus the final circulating pressure becomes the controlling factor. The new mud is pumped through the annulus while controlling back pressure on the choke to maintain this final pump pressure.

The casing pressure will vary considerably while displacement proceeds and the maximum pressure will be recorded when a gas bubble (if any) first reaches the surface.

The highest pressure recorded at any point in the well (e.g. the casing shoe) will occur when the top of any such gas bubble reaches that point.

Once new mud is returned to the surface, the well is once more balanced and back pressure required at the choke will be reduced to zero. The well may then be shut in once more to determine if the new weight is effectively controlling the formation pressure.

The higher annulus pressure associated with the driller's method for controlling a kick may become of serious concern if an inner casing string has a low pressure rating or if it is set at a shallow depth where fracture pressure in a formation is less than the probable annulus pressure that will occur when a gas bubble reaches the shoe. For this reason, cautious evaluation of well parameters needs to apply when selecting the method for controlling a well.

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Well Shut in Procedures:

If the well is flowing, the drill crew should shut in the well and make the necessary arrangements to begin killing operations. The position of the drill string at the time of this decision determines which of the following procedures to use for the shut in. Both of the 3,000 psi ball cock valves on the kill and diverter lines are maintained in the closed position at all times while drilling or coring.

1. Shut in While Drilling:

call alert
stop rotary, hoist to place tool joint above slip area
shut down pump
check both ball cock valves are open
close annular preventer
slowly close 3,000 psi ball cock valves without exceeding allowable operating pressure
when stable, read the shut in casing and shut in drill pipe pressures and record the volume gain

2. Shut in While Tripping:

call alert.
position upper tool joint above slip area
set pipe in slips & release elevators
install 3,000 psi stabbing ball cock valve open, then close
check both ball cock valves are open
close annular preventer
slowly close the diverter ball cock valves without exceeding allowable casing pressure
make up top drive rotary to top connection.
open 3,000 psi ball cock stabbing valve
allow well to stabilize
when stable, read the shut in casing and shut in drill pipe pressures and record the volume gain

3. Shut in While Out of Hole:

call alert
check both 3,000 psi diverter line ball cock valves are open
close the 5,000 psi gate valve
slowly close diverter line ball cock valves without exceeding allowable operating pressure
allow well to stabilize
read the shut in casing pressure and volume gain

4. Shut in While Retrieving Core:

The well shut in procedures are those established for carrying on wireline operations in conventional drill string assemblies.

call alert.
check both 3,000 psi diverter line ball cock valves are open
close in the packer stripper valve and by-pass valve.
slowly close diverter line ball cock valves without exceeding allowable operating pressure
allow well to stabilize.

BLOWOUT PREVENTION AND WELL CONTROL

A friction factor derived for conventional rotary drilling with a drill pipe to annulus ratio of 0.28 will be smaller than the friction factor derived where this ratio is to the order of 2.10 as is the case in wireline drilling geometries.
As a result, 92% of circulating system friction pressure losses are derived in the annulus in these down hole configurations, whereas annulus pressure losses in conventional rotary drilling geometries will generally only be to the order of 10% of circulating system pressure losses.
As a consequence, a kick event in the well may be anticipated to evacuate -

- the annulus while drilling
- the drill string while tripping
- the drill string while operating wireline tools.

As a further consequence of this distribution for friction pressure losses in a CHD circulating system, it may normally be expected while core drilling that equivalent mud densities will be higher than those in wells which are drilled using conventional oil-well rotary drilling practices.

For clarification of the following well shut in and kill procedures, a description of pressure control equipment and well data to support the drilling practices which is useful for preparing a well kill data sheet, has been included in the Appendices.

Friction Pressure Calculations:
The Power Law model for fluid flow behaviour has been employed in calculating friction pressure losses in the circulating system. The equations used to calculate the friction pressure loss are described in the IDF Drillfluids Manual and in the MI Data Handbook which is held at the location in the tool room. The circulating system pressure data obtained drilling Comalco's Ungoolya 1 in the Officer Basin of South Australia and the Pittston Minerals (Aust.), Sandfire Flat (SD1) mineral hole in the Canning Basin (described in the Slimhole Drilling Technology Manual) are empirical data sets used as models for applying these friction pressure loss equations at the location.

HW/HQ/NQ well geometries and drilling fluid properties are recorded on the kill sheet which describe the parameters used in these calculations.

The circulating system pressure loss in a well is the sum of friction pressure losses -

CSPL = P(surface) + P(drill string) + P(core barrel) + P(annulus)

When a kick is detected and the well has been shut in it is well to wait for a few minutes to allow the pressure to stabilise. If a gas bubble has been encountered it will begin to migrate up the hole and it is not good practice to wait for too long before commencing remedial action. The driller may respond in two prescribed ways to control the pressure.

He may use the recorded surface pressures to plan for kill procedures and fill in the Pressure Control Worksheet at this time, or he may wish to circulate the well through the choke using the constant pump stroke method and displace all the invading formation fluids before commencing to kill the well.

The latter, which initially controls the over-pressure by circulating the hydrostatically under-balanced well through the choke, and displaces any invading fluid from the well is called 'The Driller's Method' and will provide more reliable data to calculate mud weight to control the abnormal pressure. The method requires a minimum of two complete circulations to kill the well.

The former, is known as 'The Wait and Weight Method' is designed to kill a well with one circulation and because of simplicity it is most often preferred as the procedure.

Methods for Kick Control:
This method and a worksheet for controlling a well is described in the IDF Drillfluids Manual and the MI Drillfluids Manual which are in the tool house at the location.

BLOWOUT PREVENTION AND WELL CONTROL

A well which has been shut in may be then circulated while the driller controls the 3,000 psi diverter line ball cock valve with the original mud weight to displace an invading fluid in the annulus. A constant bottom hole pressure is maintained while circulating at the slow pump rate to control further entry of formation fluid. It is useful to complete a Well Control Worksheet before commencing the procedure.

Circulation is commenced by cracking the diverter line ball cock valve and simultaneously bring the pump rate to the desired slow pump rate. While pumping at the constant pump rate the drill string pressure is held constant by adjustment at the choke. An initial pump pressure is obtained by adding the circulating system pressure loss to the shut in drill string pressure.

When all the invading fluid has been pumped from the hole clean uncut mud will appear and the well may be shut in once more. The shut in casing pressure and the shut in drill string pressure should now be equal and a Pressure Control Worksheet may be completed using this recorded data.

It is possible to continue circulating the well at any time while weighting up operations are in progress using this constant pump stroke - constant drill string pressure method and maintain control of the well.

Regardless of the two methods employed, to kill a kicking well is the same in both cases when displacing old mud with newly weighted mud of sufficient density to effectively control the over pressure.

The operation may proceed after the initial shut in, without displacing the invading fluid using the 'Wait & Weight Method' or it may proceed this circulation using the 'Drillers Method' to control the kick. In both cases the shut in pressures are used to fill out the Pressure Control Worksheet and mud density is increased in the pits to effectively control the abnormal pressure.

The Pressure Control Worksheet:
This work sheet is used for recording shut in data and is kept up to date during drilling operations to maintain the pre-recorded information which includes the circulating system pressure loss with the pump and well data.

Record the shut in drill string and the shut in casing pressure together with the kick volume. The initial circulating pressure required is found by adding the shut in drill string pressure to the system pressure loss.

The new mud density required to balance the formation pressure may be calculated from the shut in drill string pressure. This pressure is converted to an equivalent mud density (ECD) in units of specific gravity using the equation described on the worksheet. Adding the result to the original mud density will provide the new mud specific gravity which is required to balance the formation.

It is necessary to displace the original drilling mud in the drill string and annulus with newly weighted mud while pumping with a controlled pump rate and making adjustments at the diverter ball cock choke valve to maintain a regulated pressure. The pressure is regulated to reduce the pump pressure from the Initial Circulating Pressure to the Final Circulating Pressure as the old mud is pumped out of the drill string. Calculate the Final Circulating Pressure using the equation shown in the worksheet and then prepare a graph plan which plots the number of pump strokes and/or time vs the decrease in pumping pressure while the new mud is being pumped from the surface to the bottom of the drill string. This Final Circulating Pressure is then maintained by controlling the choke while pumping the new mud up through the annulus.

Remember when making these calculations

> the drill string hydrostatic pressure + the circulating system pressure - the friction pressure
> is always equal to
> the annulus hydrostatic pressure + the casing pressure + friction pressure in the annulus.

BLOWOUT PREVENTION AND WELL CONTROL

Blowout Prevention Equipment
2" NPT 3,000 psi Diverter Line
2" NPT 3,000 psi Kill Line
2" NPT 3,000 psi Ball Cock Kill Line Valve
2" NPT 3,000 psi Ball Cock Diverter Line Valve
Cameron 3,000 psi NPT/Reg Kill Line Pressure Gauge
Cameron 3,000 psi NPT/Reg Diverter Line Pressure Gauge
Remet HW API Type 6B Flanged 1,000 psi Working Pressure Annular Blowout Preventer
Remet HQ/NQ 1,000 psi Working Pressure Bag Annulars
Demco 4 1/8" API Type 6B Flanged 5,000 psi Working Pressure Gate Valve
Feaver Engineering 4 1/8", API Type 6B Flanged 3,000 psi Working Pressure Diverter Spool
Feaver Engineering API Type 6B HW Casing Head Flange
Universal Fastners 7 1/16" 3,000 psi Flange Bolts (24)
R 45 API Type R Ring-joint Gaskets (4)
General Hydraulics Annular Preventer Closing Unit

Feaver Engineering 3,000 psi rated pressure Inside BOP
Feaver Engineering 1,000 psi rated pressure Wireline BOP

FMC 56 Bean Triplex 60 US gal/min 1,500 psi working pressure Kill Pump
NPT Mud Line Manifold

FMC 535 Bean 35 US gal/min, 1,200 psi working pressureTriplex Mud Pump

BLOWOUT PREVENTION AND WELL CONTROL

Makeup of HQ/NQ Blowout Preventer Stack on HW Casing Head Flange
After the setting and cementing of the HW casing string the cellar is prepared to a depth to expose the top joint of the HW casing string.

A 2 part portable cellar is then made up in the excavated area and a cement baseprepared. Where there is sufficient slope a drain pipe may be run from the cellar floor an external pit.

The top flange is made up on the top joint pin thread.

The Blowout Preventer Assembly is then made up on the top head flange in the cellar (see diagram).

Make the flang head bolts and torque with a tension wrench

Install 2" NPT kill line, 3000 psi ball ball valve, and 3,000 psi kill line pump manifold

Install 5,000 psi Pressure Gauge , 3,000 psi ball cock valve in exit line

Nipple up exit line to flare line and construct the flare pit

Install and test the HQ bag preventer for HQ coring. Install and test the NQ bag preventer for NQ coring

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BLOWOUT PREVENTION AND WELL CONTROL

Blowout Preventer Test Schedule:
The Test Schedule require test pressures of 5,170 Kpa (750 psi). Pressure test policy requires that the BOP's and associated well control equipment is tested to operation pressures recommended by the manufacturers.

Testing may be carried out with the least number of valve manipulations and in accordance with the instructions of the operating company.

In the event that a test indicates that the equipment is not operating correctly, operations shall not be continued until the deficiencies have been corrected to the satisfaction of the operating company.

All preventor equipment to be tested in accordance of such regulations requires that annular type blowout preventors shall be tested to 70% of the manufacturers rated pressure.

A complete BOP test is carried out at the installation of the equipment, before drilling out after setting each casing string, every 7 days while drilling and after each time repairs are made that require removal of a pressure seal in the assembly. The gate valve shall be tested at the times stipulated in the above paragraph, providing that after installing each casing string, the gate valve shall be pressure tested to the operating pressure provided above.

The annular preventors shall be function tested on each round trip or 24 hour period, which ever is the greater period of time with the exception of the annular type blowout preventors.

In conjunction with BOP tests, pressure tests of the inside BOP's, and rig mudlines require attention at this time.
The pressure test for the rig mud line and pump manifold is 750 psi

Closing Unit:
1. Accumulators shall be located adjacent to the drillers consul with sufficient capacity at all times to close the annular type blowout preventor
2. Rig hydraulic pump shall be capable of rebuilding fluid pressure in the closing unit within a period of three minutes to a sufficiently high level to close the annular type blowout preventor.
3. Closing unit shall be connected to the blowout preventors with lines of working pressure at least equal to the working pressure of the unit.
4. Closing unit shall have an independent manual backup sources of power.

Closing Unit Tests
Tests are performed at installation or every 15 days, whichever is the shorter period of time. Regardless of the arrangement of a blowout preventor stack to be tested, a set of drawings is most useful when conducting this procedure. Tests are carried out with the least number of valve manipulations.

The diagrams (Figs. 1.to 5.) included in the following pages are for general information when carrying on BOP stack test procedures. All BOP testing is carried out using water after mud is flushed from the stack and lines. Low pressure tests must be applied for 3 minutes before increasing to the full test pressure on ram and annular BOP tests.

BOP Inspection Test Check List:
Make frequent inspection to your satisfaction that you have;
Ensured the BOP's are correctly installed and braced.
Replaced hand wheels.
Ensured the 3,000 psi ball cock valves on the diverter and kill lines are closed.
Sufficient barite to meet location requirements
Hydraulic properties recorded daily in the Pressure Control Worksheet.
Drills and Safety Meeting requirements fully observed.
Tested the stand pipe, pump lines, valves and mud line hose.

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SHITTIM 1A
RIG SAFETY AND EMERGENCY RESPONSE

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RIG SAFETY AND EMERGENCY RESPONSE

CONTENT

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RIG SAFETY & EMERGENCY RESPONSE

Emergency Response

9:1:1. Introduction
The Safety and Emergency Response Program is prepared for the benefit of the Contracting drilling crews and management to ensure the correct response to emergencies which may arise out of contracting operations from time to time and for the laying down of guide lines for safe procedures when working on or around the drilling site.

Drilling supervisors are responsible to ensure that all personnel employed on the site are fully conversant with the content of this manual and are instructed in safe working practices on these operations. Pontil Pty Ltd, the Drilling Contractors, have a company hand book which is issued to all of the staff and provides the same information contained herein.

Company contractor personnel are then expected to sign the Safety Book to acknowledge they are fully aware and will abide by these instructions.

The Operator Company, Condor Oil Investments Pty Ltd, have prepared an Emergency Response Manual which covers those contingencies for the drilling programme being conducted.

Should an emergency arise, nothing in the contents, instructions or regulations provided in this programme shall be so constructed as to prevent the "person-in-charge" from taking the most effective action in his judgement for rectifying the conditions causing the emergency or action deemed necessary for the saving of life and property.

Emergency Alert Plan
An emergency is considered to be an unexpected event that may result in harm to life, environment or property and which calls for immediate action.

Examples
1. An event that results in loss of life, serious injury or causes a potential hazard to life and property.
2. Hydrocarbon or chemical spill or other emission harmful to the environment.
3. A fire causing equipment or property damage.
4. Explosion, rupture or well blow out.

Senior Company Employee at the scene
Contact the Operating Company Representative on site or at his location and report the emergency, where it occurred, when, what action is being taken to control the situation and what progress is being achieved in rectifying the emergency.

The Operating Company Representative in these circumstances is Mr Ted McNally

Tel. (002) 296576 After Hours (002) 296 576

The Senior Company Employee is then responsible for reporting the emergency to his immediate senior at the Contracting Company Head Office.

The Immediate Senior at the Contracting Company in these circumstances is Mr Tom Brown

Tel. (068) 84 2722 After Hours (068)

Your immediate reports then are ;
1. Operation Site Representative
2. Contracting Company Superior

RIG SAFETY & EMERGENCY RESPONSE

Emergency Response
A list of operating company personnel to whom you may report emergencies, will need to be prepared and kept handy in the supervisors office. Make sure that the contact level for these situations is fully established for each drilling programme.

9:1:2. Rig Emergency Procedure
The circumstances that will be encountered in any particular emergency are very often unpredictable. No all comprehending set of plans can be formulated to meet all emergencies, however normal reparations are the response for ;

1. Fire, explosion or blow out
2. An urgent need for medical assistance

Contracting Emergency Staff Team

1. Drilling Manager
   Mr

2. Senior Drilling Supervisor
   Mr

3. Co-ordinator 24 hour contact
   Mr

9:1:3. Contractor Emergency Staff Response

1. Alert all members of the team.
2. Contact the senior member of the Operator's emergency staff.
3. Base the emergency team at the radio contact room.
4. Liase with the Operator's rig supervisor.
5. Liase with the Contractor Rig Supervisor at the location.
6. Ensure names and addresses of personnel on the rig are known.
7. Prepare response for the State Regulators.

Supply
As advised by the Operator,

1. Prepare warehouse personnel responsible for materials dispatch.
2. Mobilise and dispatch any materials requested to the rig.
3. Ascertain if any injured personnel are in need of evacuation.
4. Prepare mobilization for any evacuation.
5. Advise the local Police Department of the emergency.
6. Request Police assistance if necessary.
7. If necessary advise the most accessible medical facility.
8. Arrange medical assistance in transit if necessary.
9. Arrange emergency accommodation if necessary.
10. Maintain a record of evacuees, their location and condition.
11. Report back all Operator advised action.

Operator's Representative
The Operator will detail an Emergency Response Co-ordinator to supervise the operations and it is important the Condor Oil Investments Pty Ltd emergency staff act through his instructions. In these circumstances the person in charge is Mr Ted McNally.

RIG SAFETY & EMERGENCY RESPONSE

Emergency Response

This Co-ordinating Supervisor has ultimate responsibility and will be making the decisions which are remedial for the emergency at the site and contingent to safe passage of any evacuees for medical purposes.

The Contracting organisation is responsible to act promptly on any proposed operation detailed and requested by this representative and to keep him fully informed as to the out come of the actions. Further, they are to advise him in all matters pertaining to the emergency, either requested or otherwise.

RIG SAFETY & EMERGENCY RESPONSE

Rig Safety

9:2:1. Introduction to Fire Fighting Procedures
In the petroleum industry and particularly for exploration, fire is an ever present hazard to life and property. It is necessary that the required fire fighting equipment on the rig is correctly serviced and maintained at convenient designated locations and that personnel are fully instructed in the effectively understood procedures for extinguishing any conflagration.

Burning and welding are two notable hazards that require attention and control at the location and preparation notices must always be requested for these activities so there is no breach of any regulation and so supervision is prepared for the job.

Sources for ignition
It is recognized that most of the hazard surrounding the occurrence of fires stems from lack of attention on the part of personnel to preparation and care on a job. Consideration for any sources of ignition during the carrying on of an activity and exclusion of the hazard potential through job preparation will lower the risk for accidental fire considerably. Think hard on this and your own past experience!

Ignition may result from;

1. An explosion, naked flame, molten sparks or spontaneous combustion.
2. Welding, cutting and sparks generated through cutting or grinding.
3. Electrical faults; loose connections or incorrect grounding.
4. Electrical faults; incorrect grounding or overloading.
5. Electrical faults; incorrect wiring or fuse placement.
6. Electrical faults; short circuits or unprotected installations.
7. Smoking in non designated areas.

9:2:2. Classification of fires and methods for their control
Fires have been classified as follows;

Solid Fires
extinguished using water, foam or any type extinguisher.

Liquid Fires
extinguished using foam, carbon dioxide or dry chemical.

Electrical Fires
extinguished using carbon dioxide or dry chemical.

DO NOT USE WATER OR FOAM TO EXTINGUISH ELECTRICAL FIRES.

9:2:3. Rig Fire Prevention
It is the responsibility of the Operating Company Supervisor to ensure that fire prevention and safety procedures are carried out on a location to the satisfaction of his companies set policy.

It is the responsibility of the Contracting Company Supervisor to ensure that his crew is performing duties in accordance with instructions provided by the Operator.

A Contracting Rig Supervisor should instruct crews of the following rig fire prevention responsibilities;
Ensure that the fire prevention procedures are introduced and displayed at the rig and are given attention in Safety Meeting Agendas.
Ensure that Fire Station notices are well prepared and displayed conspicuously around the rig. These notices contain equipment and duty information for personnel.

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RIG SAFETY & EMERGENCY RESPONSE

Rig Safety
Ensure that new crew members taking up duties on the location are fully briefed in fire prevention and their responsibilities in an emergency situation.

Rig crew commencing operations at a site, are required to sign a log book to acknowledge that they have been instructed in fire prevention and rig safety in general.

All visitors to the rig are to be made aware of restriction notices and safety regulations operating at the site.

All fire extinguishers required under the regulations are to be correctly positioned at the site, are to be reported as inspected and operational at the commencement of drilling operations and thereafter every three months.

Smoking is only permitted in designated areas.

Electrical installations are to be inspected by a qualified electrician before the commencement of drilling operations and then following the installation of any replaced or additional new electrical installation.

Compressed gas cylinders are not to be operated unless the are installed with gauge and pressure regulating equipment.

Spilled hydrocarbons are to be immediately recovered even if it is necessary to curtail operations in doing so.

Engine oil is drained and stored in drums at the site. It is not permitted that drained oil is held in sumps under motors.

Waste oil rags, sacks, rope, plastic containers are not to be left around the location, but deposited in designated refuse containers on site.

9:2:4. Responsibility
The Contractor Supervisor and each service company senior representative is responsible for his unit and personnel safety.

The Contractor Supervisor is the person-in-charge of fire fighting on the rig.

This responsibility may be shared by the operator supervising staff or a deputy where operator liabilities are involved i.e. danger or damage to life, the well, the reservoir or property. In the event of fire, all precautions will be taken to eliminate danger to life and property even if drilling operations have to be curtailed as a result.

Responsibility for manning and operating fire stations will be properly delegated. Back up equipment and personnel are to be mobilised quickly.

If a fire cannot be brought under control on the rig with the resources at hand then the supervisor is required to inform the Operator and proceed to notify his company emergency staff that back up equipment is required forthwith.

9:2:5. Cutting & Welding
Authorization for welding jobs are provided by the contracting supervisor or a member of the crew delegated by him and each job needs to be detailed for his approval on a Welder's Job Sheet.

Cutting and welding operations need to be properly supervised and an inspection of the work area should be carried out to determine if the work is necessary and safe to carry out.

RIG SAFETY & EMERGENCY RESPONSE

Rig Safety
Ensure that the welder fully understands the work, that he is qualified to carry it out and that fire equipment is on hand.

9:2:6. Inspection
During pre-operation, inspection ensure that;

No spark, flame, or hot slag is likely to be blown or fall onto combustible material or equipment which could be ignited and cause damage.

No combustible vapours are present in open or confined spaces which could be ignited and adequate ventilation is provided while the work is in progress to prevent the accumulation of combustible or noxious fumes. Good ventilation is essential when cutting or welding alloy metals, plated steel or painted metal since harmful vapours will be produced.

If hydrocarbons are present on the metal surface, it should be thoroughly cleaned to remove as far as possible any residue which could foreseeable cause ignition.

Where welding or cutting is to be performed around any timber, the wood is well watered down before work commences, and that periodic wetting is kept up while the work is in progress.

Welding equipment is never used in the vicinity of asbestos material.

Any welding work to be carried out on service or connecting pipe is not commenced until inspection ensures that the pipe has been bled to atmospheric pressure, that it has been purged and cleaned and that there is no possibility of pressure rebuilding in the pipe during the operation.

Make sure that all connecting valves are correctly closed and any flanges to be used are correctly installed.

If work is to be performed on any structural member, no damage to the specification of the equipment will result so that the strength or efficiency of the member is in any way reduced.

Where any work of this nature is to be performed and the supervisor is unsure of the consequences of the job, another opinion will need to be sought from a higher authority.

9:2:7. Welding in Confined Spaces
Welding in confined spaces will require that the supervisor ensures;

any welding to be conducted in a tank compartment of any kind and regardless of its features, is not commenced before it has been inspected and ascertained that it is safe to proceed with the job,

a person who is designated to carry on the job is familiar with the work and that the compartment is free of any noxious or inflammable vapours,

air blowers are placed strategically to pick up and discharge any produced fumes,

ready access to and from the place of work is freely available,

at least one other observer is in attendance while the job is in progress and that the welder has a life line to signal for rescue should difficulties arise,

RIG SAFETY & EMERGENCY RESPONSE

Rig Safety
no person is permitted to enter the compartment if there is the slightest doubt that sufficient air to support life without self containing breathing apparatus is available,

service or connecting pipe is inspected and is to the requirements stated in the above and

where-ever possible, positive closures such as blind flanges, bull plugs or locked valves are employed on pipe lines entering confined spaces while this work is in progress.

9:2:8. The Use of an Observer
Welding operations on the rig unit and within a 15 meter radius of the well head shall not be permitted unless an observer is present to watch for flying sparks and falling slag so that no fire hazard is permitted from such an occasion.

Where welding operations are to be permitted within a 15 m. radius the well head while drilling is in progress, the welder and his observer are to arrange a system of signals which will provide for a job to be shut down in the event that a hazardous situation arises.

9:2:9. Electric Arc Welding
Inspection by the supervisor should ensure that;
the welder on the job is experienced and qualified to carry on the work which has been planned,

the welding equipment, leads, ground terminals and the environment where the work is to be carried on are satisfactory for the completion of the work,

a ground return connection is not made through a conductor such as a pipe or other object which may contain inflammable liquids or gasses and

the connection is similarly not to be made through other cables, conduits, chains, wire rope or carriers of this nature.

9:2:10. Operator safety
The welder and his assistant observer are required to be correctly attired and equipped for the duties of carrying on welding operations.

Clothing which is protective of sparks, hot slag, and ultra violet rays are necessary and should cover the hole body below a mask.

Shirt sleeves are to be rolled down.

Welding masks and goggles for electric welding and flame torch welding and cutting as well as gloves are to be supplied for the welder and his observer with any welding rig.

Shielding to protect other crew members from any harmful effects arising from welding practice must also be provided.

The work area should be recovered a the completion of the job and it is important to dispose of any rod ends that have been discarded.

RIG SAFETY & EMERGENCY RESPONSE

Rig Safety

9:2:11. Oxy - Acetylene Flame Cutting and Welding
Gas cylinders are to be stored outside a 15 meter radius of the well head and should be handled in a cradle to prevent the possibility of damage.

The cylinders should be stored and secured in an up-right position and capped unless they are in use. Ensure that cylinders which have been in use and are to be transported off a location, have been recapped for transport.

The storage area at the location should be one that is free from grease or other lubricants since these materials on the bottles and hoses will present a fire risk.

Cylinders should be stored in a protected location on the rig, out of the direct rays of the sun, outside any fire risk area, away from corrosive chemicals and out of work areas where they may be exposed to sparks of naked flames.

The cylinders are never to be used for jobbing to act as rollers or supports for other equipment.

It is important to match correctly, regulators and gauges for the gas rig. Never allow an oxygen regulator to be used on an inflammable gas bottle and ensure the rig personnel are familiar with colour codes for the appliance.

Never force threads or connections when breaking down or assembling the regulators. Always keep the tread area on bottles and regulators clean and away from harm when they are not in use. If leaks are to be explored, use a soap solution to detect any leak; not an inflammable solution. Don't permit any torch work using equipment which is leaking or defective in any other way.

Don't use oxygen as a source for compressed air or permit acetylene to escape into an enclosed space.

Ensure that the welder is experienced in the work that has been scheduled and that he is qualified to carry on the work. Supervise each job until inspection confirms correct procedures for handling the equipment are being observed and the work is being carried out in accordance with the job detail.

9:2:12. Safety Responsibility
It is the responsibility of the operator company to provide its emergency response programme for the handling of toxic hydrogen sulphide gas which may be vented while drilling. The occurrence of the gas is to be fully reported in the daily log and a full written report is to be made of each incident involving detection of the gas. The operator company may delegate duties for the safe handling of the gas to the Contractor Rig Supervisor in any situation which involves its occurrence during drilling operations.

RIG SAFETY & EMERGENCY RESPONSE

Basic First Aid

9:4:1. First Aid at the Rig Site
Personnel at the rig site are trained to perform First Aid in the event of accident during operations to assist an accident victim prior to any requirement for additional professional medical assistance.

A First Aid Certificate is a valuable qualification to have and can result in the saving of a life. All crew personnel are encouraged to train for this certificate and are assisted by contractors to obtain the certificate.

Emergency procedures (including communications with head office) needs to be fully explained by the person in charge at a location and strictly adhered to.

Even minor injuries should be treated and reported on an accident report form. It is impotant the accident victim complete a Workers Compensation Report Form as soon as possible after any accident which involves such a claim.

9:4:2. Basic First Aid for Wounds
Any break in the skin can become infected if it is not promptly treated and the first aid treatment should be aimed at stopping any such infection from happening. Wash your hands before attempting any first aid.

Minor or Superficial Cuts, Scrapes or Scratches
Cleans the wound with a clean gauze pad or cotton wool using warm soapy water or a mild disinfectant, making sure to wash away from the wound and not towards it.

Rinse after cleaning with clean water and dry.

Apply antiseptic spray, cream or lotion to cover the wound and hold a gauze pad firmly to cover the damage.

Tape or bandage the gauze firmly but not so tight as to interfear with circulation.

Do not use skimpy dressings but make sure the wound and surrounding area is adequately covered.

Do not use cotton wool or adhesive tape directly to any part of the wounded area.

Deep or Extensive Wounds
Control the bleeding using a clean gauze pad and pressure over the wound.

If one pad becomes saturated place another on the top of the first pad and continue to apply pressure.

When the bleeding stops bandage the wound firmly but not too tightly.

If bleeding from a wound on a limb continues unabated, apply pressure to the artery which supplies the limb.

Should this fail it is necessary to apply a torniquet. Once a torniquet is applied it is not removed until a doctor has been called to the victim. It may be loosened for short periods from time to time on the advice of a doctor before he reaches the victim in order to permit circulation to the rest of the limb. A torniquet is made of flat material about 5 cm. in width and is applied to the normal skin about 2.5 cm above the wound.

Obtain medical assistance as soon as possible.

Watch for any impending sign of shock and treat immediately if signs become obvious.

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RIG SAFETY & EMERGENCY RESPONSE

Basic First Aid

Deep Puncture Wounds
Encourage bleeding by applying pressure around the wound.

Rinse the wound with clear water and cover with a sterile pad held in place with tape or a bandage.

Seek medical assistance.

Wounds with Foreign Bodies - Metal, Sand or Glass etc.
Do not attempt to probe for foreign bodies but pick off any particles which may be obviously removed. It is better to cover the wound with foreign bodies and all using a sterile gauze held in place with tape or a bandage.

Seek medical assistance as soon as is practical.

Injuries Caused by Crushing.
Lay yhe injured person down and cut away the clothing from the injury.

Control bleeding with gauze pads and treat the victim for shock.

Wrap the injury with gauze pads and bandage well. Keep the injured part of the body elevated.

If a fracture exists, splint the limb befor moving the victim.

Request immediate medical attention.

9:4:3. Fractures
Fractures may be either simple or compound. In the case of the simple fracture a bone may be broken but the skin is not pierced.

Compound fractures are generally more serious and involve broken bones with pircing of the skin. In these cases there is likely to be a wound above the break with bleeding and the bone end may protrude from the skin.

Fractures may be recognised;
- where a victim heard the bone snap and can feel grating,
- where pain or tenderness exists in the region of the break,
- where partial or complete loss of the use of the limb exists,
- where there is deformity in the limb or
- where the limb is abnormally positioned or shows swelling or discolouration.

First Aid Treatment
Do not move the injured person more than is necessary.

Where possible merely place a bag of ice over the fracture and seek immediate medical assistance.

If a fracture is suspected treat it as the real thing unless a doctor tells you other wise.

Treat for Shock After the Injury
If the injured person needs to be moved it is first necessary to apply splints to immobilise the limb handle slowly and gently onto a stretcher.

RIG SAFETY & EMERGENCY RESPONSE

Production Testing

9:3:1. Production Testing
Well testing is supervised by the operator and crews for drill stem testing are supplied by service companies who supply down hole tooling and specialise in these operations.

Contractor personnel are provided to assist in the operation and the supervisor and or driller are generally required to run the down hole string with the assistance of a normal floor crew.

During the testing the driller is retained to work the string. Reporting for a drill stem test is from the time the string reaches the down hole location in the well, until the test tool is brought back and laid down on the surface.

Some Operators have especially prepared emergency response procedures for test operations and these may be distributed on the location.

The supervisor will inform crews of their assigned duties in the event of any emergency.

9:3:2. Procedures
The Contractor Rig Supervisor is required to notify all crew and Operator personnel that the tool is positioned down hole and that testing is to commence.

The supervisor is required to ensure that;
adequate signs are placed on the rig to inform all personnel that all welding operations are suspended for the duration of the test,

the signs should also warn that no naked flame is permitted on the location during this period,

no smoking is permitted on the location during the test, either in or away from designated areas,

smoking is confined to enclosed accommodation areas only,

fire fighting equipment which has already been strategically positioned should also support the drill floor and the gas separator locations and

all available water outlets and hoses need to be run tested before the test is commenced.

The Operator is often obliged to provide self sustaining breathing apparatus and gas masks on the location in many areas for test operations. Condor Oil Investments Pty Ltd may be requested to provide this equipment in the event and should have access to and be able to supply the necessary items. Frequently one oxygen mask for each 3rd. man working on the test will be required.

Great care is required by crews working on the rig floor in order that no articles of equipment are carelessly permitted to slip down the hole. Maintain the drill floor so that all tools and other test tool items are handled away from the well head.

Drill stem tests are not scheduled to commence during hours of darkness and are programmed to be completed during daylight hours. This is not the case for wire line Formation Interval Testing however.
Only persons directly connected with the test are permitted in the area of testing or on the drill floor.

Test supervisors and service personnel conducting these tests are frequently working under difficult conditions and are grateful for quiet assistance offered by crews.

RIG SAFETY & EMERGENCY RESPONSE

Production Testing

9:3:3. Gas Detection During Drilling & Testing
Gas detection is the responsibility of the operator company, and in normal situations two gas detectors are employed to detect and record flammable vapours around the rig and at the well head discharge.

Hydrogen Sulphide Gas - (H_2S)
Hydrogen Sulphide gas has not been reported on drilling operations in this basin during past exploration. Where it occurs the gas is normally controlled by attention to drilling and mud engineering practices.

Because of the highly toxic properties of this gas and its free occurrence in nature much effort has gone into understanding how to combat its deadly release from wells, particularly in wild cat drilling country where it may not be anticipated as a source for concern until it is too late.

The price of that neglect has often been catastrophic loss of life. Hydrogen Sulphide is a colourless gas which is heavier than air and soluble in water. In minute quantities it has a smell similar to rotten eggs (rotten egg gas).

Detection of the gas on a location by smell alone, is not an effective means for monitoring its occurrence since a person exposed to this gas in concentrations of 1 to 2 parts per million for a period of 2 to 15 minutes will loose the sense of its smell.

From concentrations of as little as 2 to 200 ppm people exposed to the gas will loose their sense of smell for the gas and will suffer burning in the eyes and throat.

At a concentration of 500 ppm in air (about .05%) the gas causes loss of the sense of reasoning and balance and respiratory disturbance all in the space of from 2 to 15 minutes.

At 700 ppm an exposed victim quickly looses consciouses and breathing stops.
At 1000 ppm an exposed victim immediately looses consciouses.

Such is the concern of this industry, and it has many examples which are conclusive for its appreciation of the life threatening properties of the gas, that it has spent many millions of dollars to educate, and train its people in safe, effective methods for handling its occurrence when drilling.

The progress towards safe handling for the occurrence of hydrogen sulphide gas in drilling today means that any catastrophic event from its eventuality has resulted from a lack of planning foresight.

The booklet which is enclosed in the appendices of this manual deals with all aspects of hydrogen sulphide gas; its properties and its occurrence, procedures for monitoring the gas while drilling and procedures to be adopted when detecting the gas while drilling, first aid and resuscitation then finally toxicity and symptom behaviour.

RIG SAFETY & EMERGENCY RESPONSE

Basic First Aid
In case of a compound fracture the wound is covered with gauze or a clean cloth and pressure is applied to control the bleeding before any required splinting is applied. Never attempt to push a protruding bone back into place

9:4:4. Burns & Scalds
Burns and scalds are classified in degrees of severity.

First Degree Burns are where the skin is reddened

Second Degree Burns are where blistering occurs

Third Degree Burns are where skin is charred or cooked.

First aid in the treatment of burns should be aimed at relieving pain, preventing infection and preventing or treating for shock.

There are a number of important ' DON'TS 'associated with the treatment of burns.
don't touch the burn with any thing which is not clean
don't use butter, oils or boric, tannic or picric acid based ointments
don't but absorbent cotton or blankets directly on a burn with broken skin
don't break or drain blisters
don't delay first aid treatment for shock in cases of serious burns
don't delay obtaining professional medical assistance

Treatment of First Degree Burns
apply antiseptic- analgesic burn ointment, cover with a sterile gauze pad and bandage firmly

Treatment of Second Degree Burns
administer first aid for treating shock

If the victim is conscious and thirsty and there are no abdominal wounds it is advisable to give, freely, a weak saline and bicarbonate of soda solution. Prepare the solution using half a teaspoon of bicarbonate and 2 heaped teaspoons of salt in a litre of water.

Remove clothing from the burn being careful to cut around any cloth sticking or fused to the burn.

Cover the burn area with sterile gauze or a suitable substitute such as a freshly laundered sheet or pillow case.

Make the victim comfortable and warm while seeking immediate professional medical assistance.

Third Degree Burns
Immediately administer treatment for shock.

Do nothing to the burn but cover it with sterile gauze pads or cloth.

Seek immediate professional medical treatment for the victim.

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RIG SAFETY & EMERGENCY RESPONSE

Basic First Aid

9:4:5. Treatment for Shock

Shock is a serious depression of vital functions that can often accompany even moderate injury.

In all cases of severe injury first aid for shock should be given immediately. It is important not to wait for shock to develop and to act immediately by keeping the victimlying down, warm and with an adequate supply of fluids.

All or any of the following symptoms may be present immediately followin an accident or may develope over a period of time after the event.

weakness, faintness, mental sluggishness or collapse,
paleness with cool or clammy skin,
drooping eyelids, eyes vacant and dull or dilation of pupils,
rapid and shallow breathing,
nausea and/or vomiting,
rapid, irregular or weak or too weak to feel pulse or
unconsciousness.

Treatment

Lay the victim on his back with the face upward.

Loosen clothing and elevate the feet about 30 to 50 cm. or,

For a head injury elevate the head instead of the feet.

For chest injuries and breathing difficulties elevate head and shoulders

Keep victim comfortable and warm with top and bottom blankets.

In hot weather do not make the victim uncomfortably warm.

Conscious victims with out abdominal wounds should be provided as much fluid as is comfortable for them to take provided they are not nauseous or vomiting.

A teaspoon of baking soda with half a teaspoon of salt in a litre of water is suitable as a fluid or orange juice and other soft fluids may be used.

No alcohol or stimulants should be administered.

Attend any injuries and keep the victim quiet and comfortable while waiting for professional medical assistance.

9:4:6. Responsibility

First aid practiced at a drilling location is the responsibility of the rig Safety Officer who is trained as a First Aid Orderly.

The Officer is responsible for carrying out first aid on any victim injured at the location, for dispatch of any seriously injured victim in an accident and for the requesting of medical assistance for the victim of an accident.

This person is also responsible for reporting accidents and dispatching all correspondence associated with the mishap at the location.

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SHITTIM 1A
STRATIGRAPHIC SLIMHOLE DRILLING PROGRAM

CONTINGENCY WELL PLAN
BLOWOUT PREVENTION AND WELL CONTROL
RIG SAFETY AND EMERGENCY RESPONSE

APPENDICES

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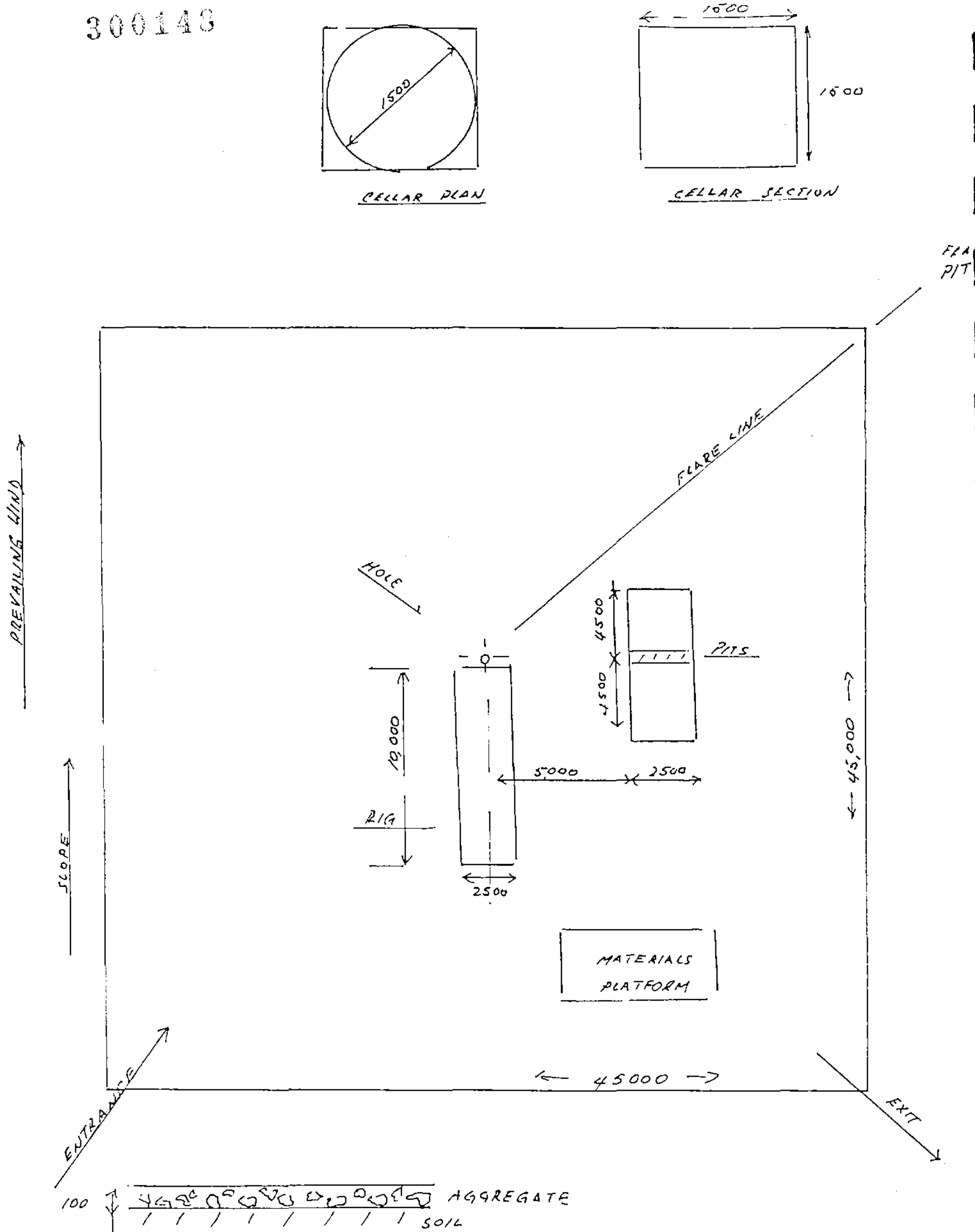


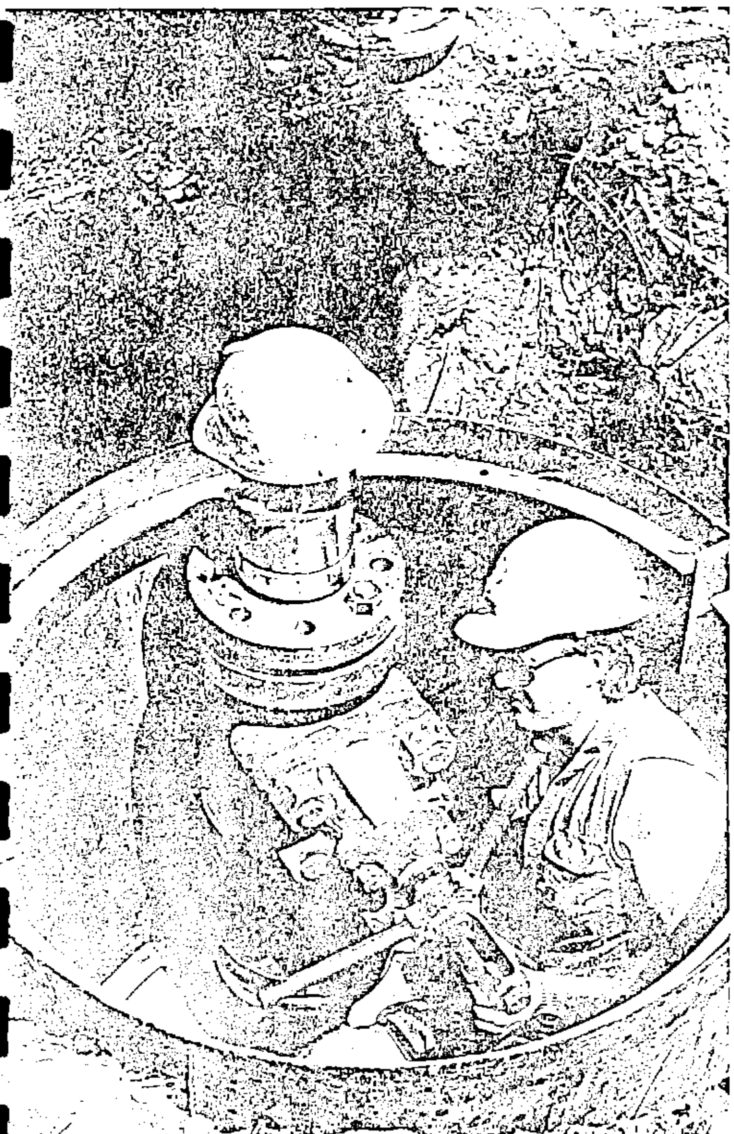
BRUNI Is. SITE PLAN

PECTIL ENGINEERING
Oil & Gas Drilling
Development Engineering

Postal address: PO Box 915, West Perth, Western Australia 687[illegible]
Telephone: (09) 481 5522 Facsimile: (09) 481 5550

NOVEMBER 1992 SANDFIRE FLAT SD#1 DRILLING LOCATION
CANNING BASIN WESTERN AUSTRALIA

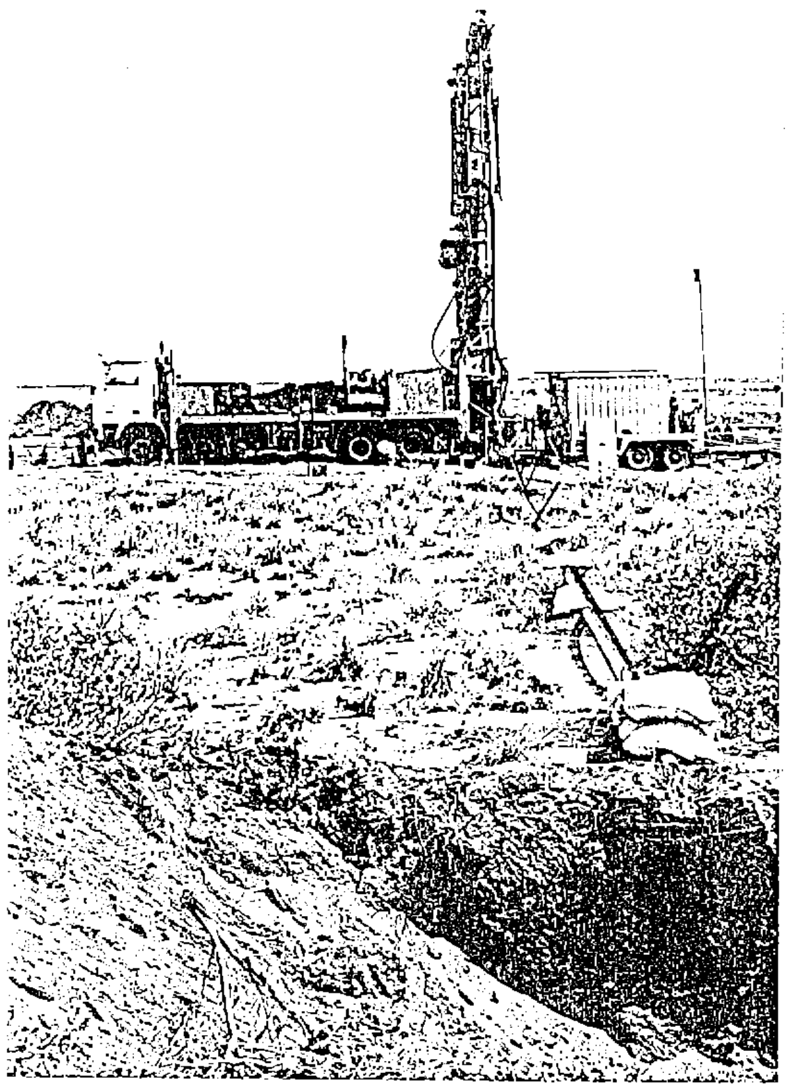
INSTALLATION OF REMET BLOWOUT PREVENTER STACK
RATED 1,000 PSI STACK TESTED TO 750 PSI WORKING PRESSURE



Pectil Engineering Services
Oil & Gas Drilling Engineering Consultants

NOVEMBER 1992 SANDFIRE FLAT SD#1 DRILLING LOCATION
CANNING BASIN WESTERN AUSTRALIA

UDR 1000 DRILL RIG
NQ DIVERTER LINE TO FLARE PIT

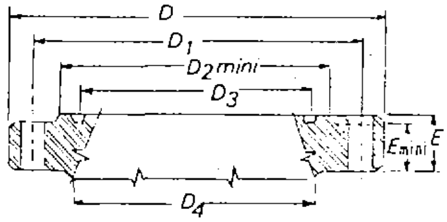


PECTIL ENGINEERING 26 COLIN STREET WEST PERTH WESTERN AUSTRALIA 6005 TEL (619) 481 3322 FAX (619) 481 3330

API TYPE 6B - 2 000 FLANGES

Maximum working pressure : 137 bars (2 000 psi)

Test pressure : flanged 14 in and smaller 275 bars (4 000 psi)
Test pressure : flanged 16 in and higher 206 bars (3 000 psi)



All dimensions in inches

Nominal size and bore (1)	Old nominal size	Outside diameter D	Total thickness E	Basic thickness E mini	Diameter of raised face D_1 mini	Diameter of hub D_4	Diameter of bolt circle D_1	Number of bolts	Diameter of bolts	Length of stud bolts	Ring-joint Type R or RX	Pitch diam. of groove D_1
1 13/16*	1 1/2	6 1/8	1 1/8	7/8	3 9/16	2 3/4	4 1/2	4	3/4	4 1/4	20	2 11/16
2 1/16	2	5 1/2	1 5/16	1	4 1/4	3 5/16	5	8	5/8	4 1/2	23	3 1/4
2 9/16	2 1/2	7 1/2	1 7/16	1 1/8	5	3 15/16	5 7/8	8	3/4	5	26	4
3 1/8	3	8 1/4	1 9/16	1 1/4	5 3/4	4 5/8	6 5/8	8	3/4	5 1/4	31	4 7/8
4 1/16	4	10 3/4	1 13/16	1 1/2	6 7/8	6	8 1/2	8	7/8	6	37	5 7/8
5 1/8*	5	13	2 1/16	1 3/4	8 1/4	7 7/16	10 1/2	8	1	6 3/4	41	7 1/8
7 1/16	6	14	2 3/16	1 7/8	9 1/2	8 3/4	11 1/2	12	1	7	45	8 5/16
9	8	16 1/2	2 1/2	2 3/16	11 7/8	10 3/4	13 3/4	12	1 1/8	8	49	10 5/8
11	10	20	2 13/15	2 1/2	14	13 1/2	17	16	1 1/4	8 3/4	53	12 3/4
13 5/8	12	22	2 15/16	2 5/8	16 1/4	15 3/4	19 1/4	20	1 1/4	9	57	15
16 3/4	16	27	3 5/16	3	20	19 1/2	23 3/4	20	1 1/2	10 1/4	65	18 1/2
17 3/4*	18	29 1/4	3 9/16	3 1/4	22 5/8	21 1/2	25 3/4	20	1 5/8	11	69	21
21 1/4	20	32	3 7/8	3 1/2	25	24	28 1/2	24	1 5/8	11 3/4	73	23

* These sizes inactive ; available on special order only.
(1) Beginning with the Eleven Edition of API Spec 6A (October 1977), the traditional 6B flange nominal size designation is changed to a through-bore designation

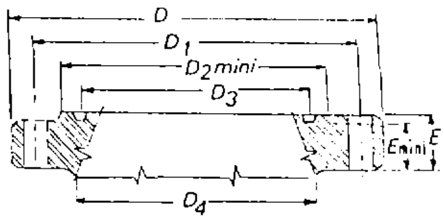
M 4

M 5

API TYPE 6B - 3 000 FLANGES

Maximum working pressure : 206 bars (3 000 psi)

Test pressure : flanged 14 in and smaller 412 bars (6 000 psi)
Test pressure : flanged 16 in and higher 3098 bars (4 500 psi)



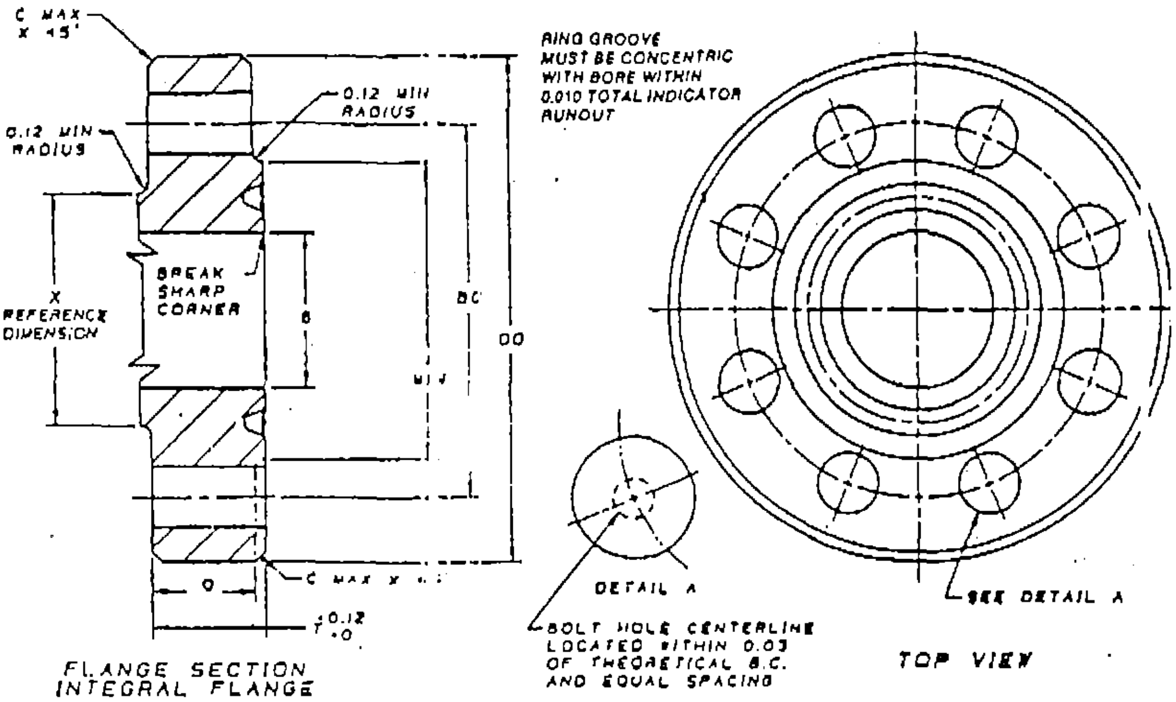
All dimensions in inches

Nominal size and bore (1)	Old nominal size	Outside diameter D	Total thickness E	Basic thickness E mini	Diameter of raised face D_1 mini	Diameter of hub D_4	Diameter of bolt circle D_1	Number of bolts	Diameter of bolts	Length of stud bolts	Ring-joint Type R or RX	Pitch diam. of groove D_1
1 13/16*	1 1/2	7	1 1/2	1 3/4	3 5/8	2 3/4	4 7/8	4	1	5 1/2	20	2 11/16
2 1/16	2	8 1/2	1 13/16	1 1/2	4 7/8	4 1/8	6 1/2	8	7/8	6	24	3 3/4
2 9/16	2 1/2	9 5/8	1 15/16	1 5/8	5 3/8	4 7/8	7 1/2	8	1	6 1/2	27	4 1/4
3 1/8	3	9 1/2	1 13/15	1 1/2	6 1/8	5	7 1/2	8	7/8	6	31	4 7/8
4 1/16	4	11 1/2	2 1/16	1 3/4	7 1/8	6 1/4	9 1/4	8	1 7/8	7	37	5 7/8
5 1/8*	5	13 3/4	2 5/15	2	8 1/2	7 1/2	11	8	1 1/4	7 3/4	41	7 1/8
7 1/16	6	15	2 1/2	2 3/16	9 1/2	9 1/4	12 1/2	12	1 1/8	8	45	8 5/16
9	8	18 1/2	2 13/16	2 1/2	12 1/8	11 3/4	15 1/2	12	1 3/8	9	49	10 5/8
11	10	21 1/2	3 1/16	2 3/4	14 1/4	14 1/2	18 1/2	16	1 3/8	9 1/2	53	12 3/4
13 5/8	12	24	3 7/16	3 1/8	16 1/2	15 1/2	21	20	1 3/8	10 1/4	57	15
16 3/4	16	27 3/4	3 15/16	3 1/2	20 5/8	20	24 1/4	20	1 5/8	11 3/4	66	18 1/2
17 3/4	18	31	4 1/2	4	23 3/8	22 1/4	27	20	1 7/8	13 3/4	70	21
21 1/4	20	33 3/4	4 3/4	4 1/4	25 1/2	24 1/2	29 1/2	20	2	14 1/2	74	23

(1) Beginning with the Eleven Edition of API Spec 6A (October 1977), the traditional 6B flange nominal size designation is changed to a through-bore designation.
* These sizes inactive ; available on special order only.
Note. Except for bore of welding neck flanges, dimensions for sizes 1 13/16 in to 2 9/16 in inclusive are indentical with 5 000 psi flanges in table next page.

300152

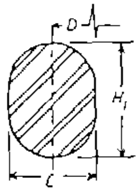
TABLE X A3
TYPE 6B FLANGES FOR
3000 psi RATED WORKING PRESSURE



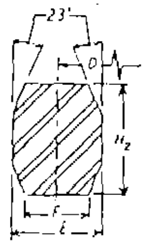
Basic Flange Dimensions									Bolting Dimensions					
Nominal Size and Bore of Flange	Max Bore B	Outside Diameter of Flange OD	Tolerance OD	Max Chamfer C	Diameter of Raised Face K	Total Thickness of Flange T	Basic Thickness of Flange Q	Diameter of Hub X	Diameter of Bolt Circle BC	Number of Bolts	Diameter of Bolts	Diameter of Bolt Holes	Bolt Hole Tolerance	Length of Stud Bolts L_{ssb}
2¹/₁₆	2.09	8.50	±0.06	0.12	4.8[illegible]	1.81	1.50	4.12	6.50	8	⅞	1.00	+.06	6.00
2⁹/₁₆	2.59	9.62	±0.06	0.12	5.[illegible]	1.94	1.62	4.88	7.50	8	1	1.12	+.06	6.50
3⅛	3.16	9.50	±0.06	0.12	6.1[illegible]	1.81	1.50	5.00	7.50	8	⅞	1.00	+.06	6.00
4¹/₁₆	4.09	11.50	±0.06	0.12	7.1[illegible]	2.06	1.75	6.25	9.25	8	1⅛	1.25	+.06	7.00
7¹/₁₆	7.09	15.00	±0.12	0.25	9.[illegible]	2.50	2.19	9.25	12.50	12	1⅛	1.25	+.06	8.00
9	9.03	18.50	±0.12	0.25	12.[illegible]	2.81	2.50	11.75	15.50	12	1⅜	1.50	+.06	9.00
11	11.03	21.50	±0.12	0.25	14.[illegible]	3.06	2.75	14.50	18.50	16	1⅜	1.50	+.06	9.50
13⅝	13.66	24.00	±0.12	0.25	16.6[illegible]	3.44	3.12	16.50	21.00	20	1⅜	1.50	+.06	10.25
16¾	16.78	27.75	±0.12	0.25	20.6[illegible]	3.94	3.50	20.00	24.25	20	1⅝	1.75	+.09	11.75
20¾	20.78	33.75	±0.12	0.25	25.6[illegible]	4.75	4.25	24.50	29.50	20	2	2.12	+.09	14.50

API TYPE R RING-JOINT GASKETS (API Spec 6A) (for use in 6B flanges)

All dimensions in inches



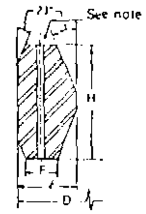
oval



octagonal

Ring number	Pitch diam. of ring D	Width of ring ℓ	Height of ring oval	Height of ring octagonal	Width of flat octagonal ring F	Approximate distance between make-up flanges
R 20	2 11/16	5/16	9/16	1/2	0.206	5/32
R 23	3 1/4	7/16	11/16	5/8	0.305	3/16
R 24	3 3/4	7/16	11/16	5/8	0.305	3/16
R 26	4	7/16	11/16	5/8	0.305	3/16
R 27	4 1/4	7/16	11/16	5/8	0.305	3/16
R 31	4 7/8	7/16	11/16	5/8	0.305	3/16
R 35	5 3/8	7/16	11/16	5/8	0.305	3/16
R 37	5 7/8	7/16	11/16	5/8	0.305	3/16
R 39	6 3/8	7/16	11/16	5/8	0.305	3/16
R 41	7 1/8	7/16	11/16	5/8	0.305	3/16
R 44	7 5/8	7/16	11/16	5/8	0.305	3/16
R 45	8 5/16	7/16	11/16	5/8	0.305	3/16
R 46	8 5/16	1/2	3/4	11/16	0.341	1/8
R 47	9	3/4	1	15/16	0.485	5/32
R 49	10 5/8	7/16	11/16	5/8	0.305	3/16
R 50	10 5/8	5/8	7/8	13/16	0.413	5/32
R 53	12 3/4	7/16	11/16	5/8	0.305	3/16
R 54	12 3/4	5/8	7/8	13/16	0.413	5/32
R 57	15	7/16	11/16	5/8	0.305	3/16
R 63	16 1/2	1	1 5/16	1 1/4	0.681	7/32
R 65	18 1/2	7/16	11/16	5/8	0.305	3/16
R 66	18 1/2	5/8	7/8	13/16	0.413	5/32
R 69	21	7/16	11/16	5/8	0.305	3/16
R 70	21	3/4	1	1	0.485	3/16
R 73	23	1/2	3/4	11/16	0.341	1/8
R 74	23	3/4	1	15/16	0.485	3/16
R 82	2 1/4	7/16	—	5/8	0.305	3/16
R 84	2 1/2	7/16	—	5/8	0.305	3/16
R 85	3 1/8	1/2	—	11/16	0.341	1/8
R 86	3 9/16	5/8	—	13/16	0.413	5/32
R 87	3 15/16	5/8	—	13/16	0.413	5/32
R 88	4 7/8	3/4	—	15/16	0.485	3/16
R 89	4 1/2	3/4	—	15/16	0.485	3/16
R 90	6 1/8	7/8	—	1 1/16	0.583	3/16
R 91	10 1/4	1 1/4	—	1 1/2	0.879	5/16
R 99	9 1/4	7/16	—	5/8	0.805	3/16

API TYPE RX PRESSURE ENERGIZED RING-JOINT GASKETS (API Spec 6A) (for use in 6B flanges and segmented flanges)



All dimensions in inches

Ring number	Outside diameter of ring D	Total width ℓ	Width of flat F	Height H	Pitch diameter of groove	Approximate distance between made-up flanges
RX 20	3	11/32	0.182	3/4	2 11/16	3/8
RX 23	3 43/64	15/32	0.254	1	3 1/4	15/32
RX 24	4 11/64	15/32	0.254	1	3 3/4	15/32
RX 26	4 13/32	15/32	0.254	1	4	15/32
RX 27	4 21/32	15/32	0.254	1	4 1/4	15/32
RX 31	5 19/64	15/32	0.254	1	4 7/8	15/32
RX 35	5 51/64	15/32	0.254	1	5 3/8	15/32
RX 37	6 19/64	15/32	0.254	1	5 7/8	15/32
RX 39	6 51/64	15/32	0.254	1	6 3/8	15/32
RX 41	7 35/64	15/32	0.254	1	7 1/8	15/32
RX 44	8 3/64	15/32	0.254	1	7 5/8	15/32
RX 45	8 47/64	15/32	0.254	1	8 5/16	15/32
RX 46	8 3/4	17/32	0.263	1 1/8	8 5/16	15/32
RX 47	9 21/32	25/32	0.407	1 5/8	9	23/32
RX 49	11 3/64	15/32	0.254	1	10 5/8	15/32
RX 50	11 5/32	21/32	0.335	1 1/4	10 5/8	15/32
RX 53	13 11/64	15/32	0.254	1	12 3/4	15/32
RX 54	13 9/32	21/32	0.335	1 1/4	12 3/4	15/32
RX 57	15 27/64	15/32	0.254	1	15	15/32
RX 63	17 25/64	1 1/16	0.582	2	16 1/2	27/32
RX 65	18 59/64	15/32	0.254	1	18 1/2	15/32
RX 66	19 1/32	21/32	0.335	1 1/4	18 1/2	15/32
RX 69	21 27/64	15/32	0.254	1	21	15/32
RX 70	21 21/32	25/32	0.407	1 5/8	21	23/32
RX 73	23 15/32	17/32	0.263	1 1/4	23	19/32
RX 74	23 21/32	25/32	0.407	1 5/8	23	23/32
RX 82	2 43/64	15/32	0.254	1	2 1/4	15/32
RX 84	2 59/64	15/32	0.254	1	2 1/2	15/32
RX 85	3 35/64	17/32	0.263	1	3 1/8	3/8
RX 86	4 5/64	19/32	0.335	1 1/8	3 9/16	3/8
RX 87	4 29/64	19/32	0.335	1 1/8	3 15/16	3/8
RX 88	5 31/64	11/16	0.407	1 1/4	4 7/8	3/8
RX 89	5 7/64	23/32	0.407	1 1/4	4 1/2	3/8
RX 90	6 7/8	25/32	0.479	1 3/4	6 1/8	23/32
RX 91	11 19/64	1 3/16	0.780	1 25/32	10 1/4	3/4
RX 99	9 43/64	15/32	0.254	1	9 1/4	15/32
RX 201	2.026	0.226	0.126	0.445	—	—
RX 205	2 29/64	7/32	0.120	0.437	—	—
RX 210	3 27/32	3/8	0.213	0.750	—	—
RX 215	5 35/64	15/32	0.210	1.000	—	—

Note. The pressure passage hole illustrated in the RX ring cross-section is required in rings RX - 82 through RX - 91 only.

300154

STUD BOLTS, NUTS, RING GASKETS, AND WRENCHES

ASTM A193 GRADE B7 MATERIAL - BOLTING
ASTM A194 GRADE 2H MATERIAL - NUTS

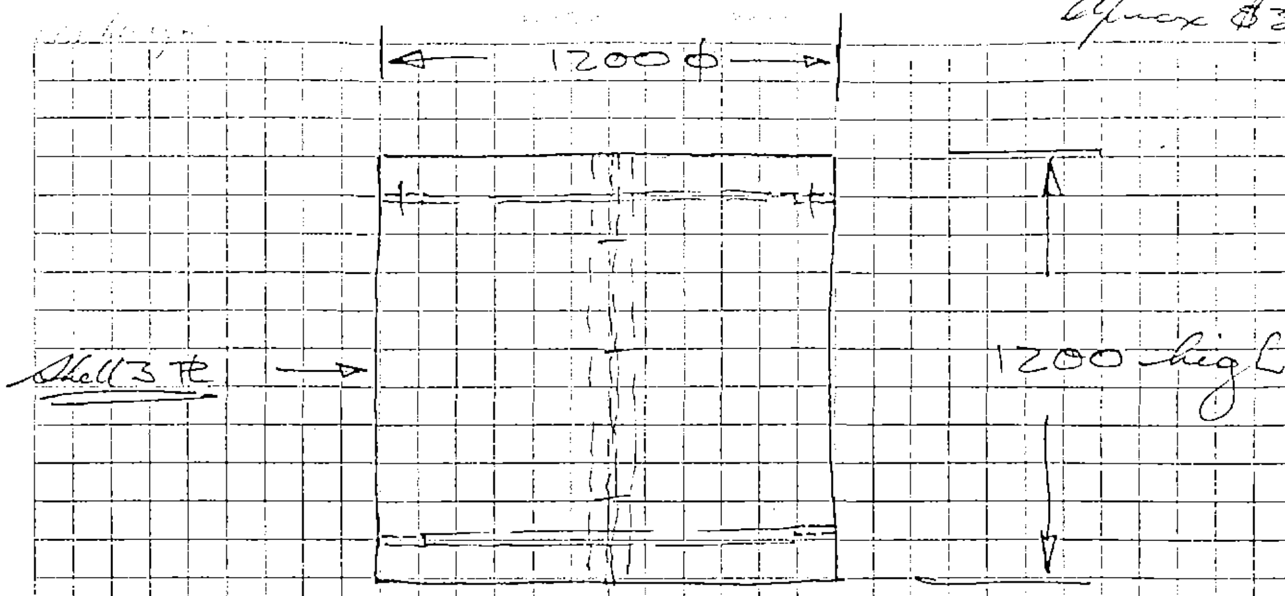
Required for Bolting Two API Flanges Together

Size and Working Pressure	Stud Diameter and Length	Number of Studs	Stud Part Number** Cadmium Plated	Nut Part Number**	Cross Wrench Part Number	API Ring Gaskets for Type 6B Flanges: R Number	API Ring Gaskets for Type 6B Flanges: CIW Part Number	Pressure Energized Gaskets for Type 6B Flanges: RX Number	Pressure Energized Gaskets for Type 6B Flanges: CIW Part Number	Pressure Energized Gaskets for Type 6B Flanges: Standoff Gap RX Rings	Pressure Energized Gaskets for Type 6BX Flanges: BX Number	Pressure Energized Gaskets for Type 6BX Flanges: CIW Part Number
1¹¹⁄₁₆" 10,000	¾" × 5¼"	8	5911-07-10	12955-07-10	7959-11	—	—	—	—	—	150	18975-01
1¹¹⁄₁₆" 15,000	¾" × 5½"	8	5911-10-10	12955-07-10	7959-11	—	—	—	—	—	150	18975-01
1¹³⁄₁₆" 10,000	¾" × 5¼"	8	5911-07-10	12955-07-10	7959-11	—	—	—	—	—	151	19058-01
1¹³⁄₁₆" 15,000	⅞" × 5½"	8	5912-06-10	12955-12-10	7959-01	—	—	—	—	—	151	19058-01
1¹³⁄₁₆" 20,000	1" × 7½"	8	5913-22-10	12955-11-10	7959-02	—	—	—	—	—	151	19058-01
2¹⁄₁₆" 2000	⅝" × 4¾"	8	8215-03-10	12955-10-10	7959-12	23	6590-18	23	19000-23	5/32"	—	—
2¹⁄₁₆" 5000	⅞" × 6½"	8	5912-20-10	12955-12-10	7959-01	24	6590-11	24	19000-24	5/32"	—	—
2¹⁄₁₆" 10,000	¾" × 5¼"	8	5911-05-10	12955-07-10	7959-11	—	—	—	—	—	152	18976-01
2¹⁄₁₆" 15,000	⅞" × 6½"	8	5912-20-10	12955-12-10	7959-01	—	—	—	—	—	152	18975-01
2¹⁄₁₆" 20,000	1⅛" × 8½"	8	5914-25-10	12955-13-10	7959-03	—	—	—	—	—	152	18976-01
2⁹⁄₁₆" 2000	¾" × 5½"	8	5911-07-10	12955-07-10	7959-11	26	6590-27	26	19000-26	5/32"	—	—
2⁹⁄₁₆" 5000	1" × 7"	8	5913-14-10	12955-11-10	7959-02	27	6590-17	27	19000-27	5/32"	—	—
2⁹⁄₁₆" 10,000	⅞" × 6½"	8	5912-20-10	12955-12-10	7959-01	—	—	—	—	—	153	19331-01
2⁹⁄₁₆" 15,000	1" × 7"	8	5913-14-10	12955-11-10	7959-02	—	—	—	—	—	153	19331-01
2⁹⁄₁₆" 20,000	1¼" × 9½"	8	5915-38-10	12955-17-10	7959-04	—	—	—	—	—	153	19331-01
3⅛" 2000	¾" × 5½"	8	5911-06-10	12955-07-10	7959-11	31	6590-09	31	19000-31	5/32"	—	—
3⅛" 3000	⅞" × 6½"	8	5912-20-10	12955-12-10	7959-01	31	6590-09	31	19000-31	5/32"	—	—
3⅛" 5000	1⅛" × 7¾"	8	5914-05-10	12955-13-10	7959-03	35	6590-10	35	19000-35	5/32"	—	—
3¹⁄₁₆" 10,000	1" × 7¼"	8	5913-19-10	12955-11-10	7959-02	—	—	—	—	—	154	19819-01
3¹⁄₁₆" 15,000	1⅛" × 8"	8	5914-15-10	12955-13-10	7959-03	—	—	—	—	—	154	19819-01
3¹⁄₁₆" 20,000	1⅜" × 10¼"	8	5917-91-10	12955-19-10	7959-05	—	—	—	—	—	154	19819-01
4¹⁄₁₆" 2000	⅞" × 6¾"	8	5912-20-10	12955-12-10	7959-01	37	6590-16	37	19000-37	5/32"	—	—
4¹⁄₁₆" 3000	1⅛" × 7½"	8	5914-09-10	12955-13-10	7959-03	37	6590-16	37	19000-37	5/32"	—	—
4¹⁄₁₆" 5000	1¼" × 8½"	8	5915-11-10	12955-17-10	7959-04	39	6590-12	39	19000-39	5/32"	—	—
4¹⁄₁₆" 10,000	1⅛" × 8½"	8	5914-23-10	12955-13-10	7959-03	—	—	—	—	—	155	25655-01
4¹⁄₁₆" 15,000	1⅜" × 9¾"	8	5917-89-10	12955-19-10	7959-05	—	—	—	—	—	155	25855-01
4¹⁄₁₆" 20,000	1¾" × 12¾"	8	7311-34-10	12955-36-10	7959-08	—	—	—	—	—	155	25655-01
7¹⁄₁₆" 2000	1" × 7½"	12	5913-25-10	12955-11-10	7959-02	45	6590-01	45	19000-45	5/32"	—	—
* 7¹⁄₁₆" 3000	1⅛" × 8½"	12	5914-25-10	12955-13-10	7959-03	45	6590-01	45	19000-45	5/32"	—	—
7¹⁄₁₆" 5000	1⅜" × 11¼"	12	5917-25-10	12955-19-10	7959-05	46	6590-38	46	19000-46	5/32"	—	—
7¹⁄₁₆" 10,000	1½" × 11¾"	12	5918-29-10	12955-31-10	7959-06	—	—	—	—	—	156	18977-01
7¹⁄₁₆" 15,000	1½" × 13"	16	5918-83-10	12955-31-10	7959-06	—	—	—	—	—	156	18977-01
7¹⁄₁₆" 20,000	2" × 18"	16	5919-48-10	12955-49-10	7959-10	—	—	—	—	—	156	18977-01
9" 2000	1⅛" × 8¾"	12	5914-25-10	12955-13-10	7959-03	49	6590-15	49	19000-49	5/32"	—	—
9" 3000	1⅜" × 9½"	12	5917-20-10	12955-19-10	7959-05	49	6590-15	49	19000-49	5/32"	—	—
9" 5000	1⅝" × 12½"	12	6306-24-10	12955-35-10	7959-07	50	6590-22	50	19000-50	5/32"	—	—
9" 10,000	1½" × 13¾"	16	5918-64-10	12955-31-10	7959-06	—	—	—	—	—	157	19822-01
9" 15,000	1⅞" × 16¾"	16	6832-63-10	12955-37-10	7959-09	—	—	—	—	—	157	19822-01
11" 2000	1¼" × 9¼"	16	5915-33-10	12955-17-10	7959-04	53	6590-07	53	19000-53	5/32"	—	—
11" 3000	1⅜" × 10"	16	5917-09-10	12955-19-10	7959-05	53	6590-07	53	19000-53	5/32"	—	—
11" 5000	1⅞" × 14½"	12	6832-01-10	12955-37-10	7959-09	54	6590-58	54	19000-54	5/32"	—	—
11" 10,000	1¾" × 15¾"	16	7311-13-10	12955-36-10	7959-08	—	—	—	—	—	158	19490-01
11" 15,000	2" × 19¾"	20	5919-36-10	12955-49-10	7959-10	—	—	—	—	—	158	19490-01
13⅝" 2000	1⅛" × 9½"	20	5915-38-10	12955-17-10	7959-04	57	6590-14	57	19000-57	5/32"	—	—
13⅝" 3000	1⅜" × 10¾"	20	5917-14-10	12955-19-10	7959-05	57	6590-14	57	19000-57	5/32"	—	—
13⅝" 5000	1⅝" × 12¾"	16	6306-35-10	12955-35-10	7959-07	—	—	—	—	—	160	29903-01
13⅝" 10,000	1⅞" × 17¼"	20	6832-42-10	12955-37-10	7959-09	—	—	—	—	—	159	19321-01
13⅝" 15,000	2¼" × 21"	20	13576-01-10	12955-38-10	7959-13	—	—	—	—	—	159	19321-01
16¾" 2000	1½" × 10¾"	20	5915-23-10	12955-31-10	7959-06	65	6590-18	65	19000-65	5/32"	—	—
16¾" 3000	1⅝" × 12½"	20	6306-16-10	12955-35-10	7959-07	66	6590-31	66	19000-66	5/32"	—	—
16¾" 5000*	1¾" × 14¾"	16	7311-13-10	12955-36-10	7959-08	—	—	—	—	—	161	40512-01
16¾" 5000	1⅞" × 14¾"	16	6832-58-10	12955-37-10	7959-09	—	—	—	—	—	162	40400-01
16¾" 10,000	1⅞" × 17½"	24	6832-42-10	12955-37-10	7959-09	—	—	—	—	—	162	40400-01
18¾" 5000	2" × 18"	20	5919-48-10	12955-49-10	7959-10	—	—	—	—	—	163	700242
18¾" 10,000	2¼" × 22¾"	24	13576-25-10	12955-38-10	7959-13	—	—	—	—	—	164	670327-03-02
21¼" 2000	1⅝" × 12¾"	24	6306-16-10	12955-35-10	7959-07	73	6590-26	73	19000-73	5/32"	—	—
20¾" 3000	2" × 15¾"	20	5919-03-10	12955-40-10	7959-10	74	6590-56	74	19000-74	5/32"	—	—

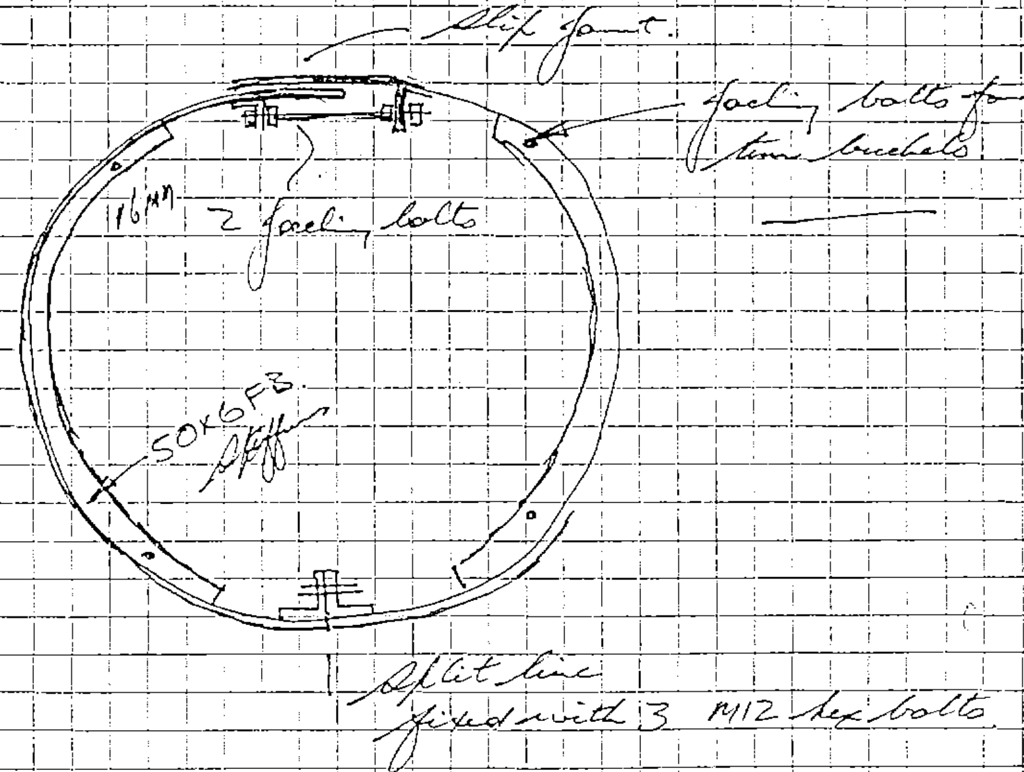
*Obsolete API 5000 psi WP 7500 Test

**For black studs and nuts, drop the second dash number (-10)

300155 [illegible] $300-00



Side View



Note

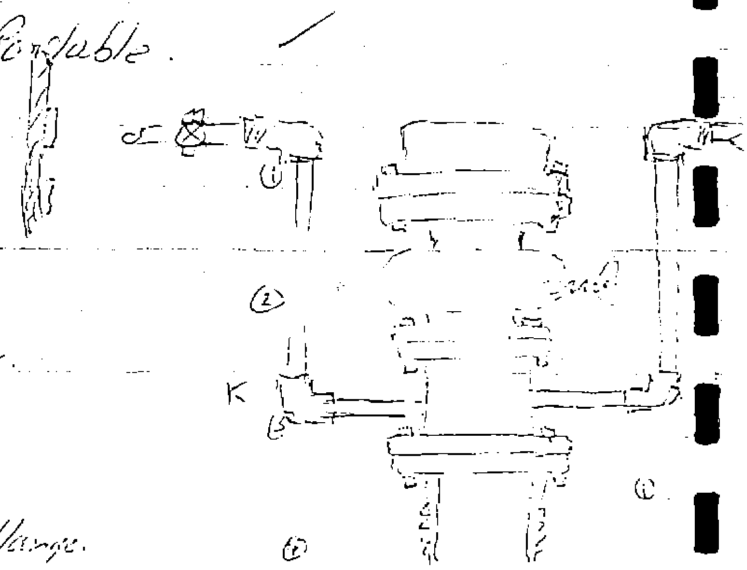
Murray wants height 1200 + ( ) = 1371

Ordered in already so it comes at 1200-

Load Out:

Wellhead Equipment.

Conkeough 4' dia Well Cellar - Portable.
4 × 1¼" Turnbuckles
6½" Casing Clamp.



1. Rental 3000psi Annular preventer.
2. Demco 4", 5000psi Gate Valve.
3. Feaver 4" Diverter Bowl.
4. Feaver 4" HW Casinghead pin flange.

D Diverter Line. 2" NPT diverter line assembly (see dia)
2" NPT - NQ Flare line XO Sub.

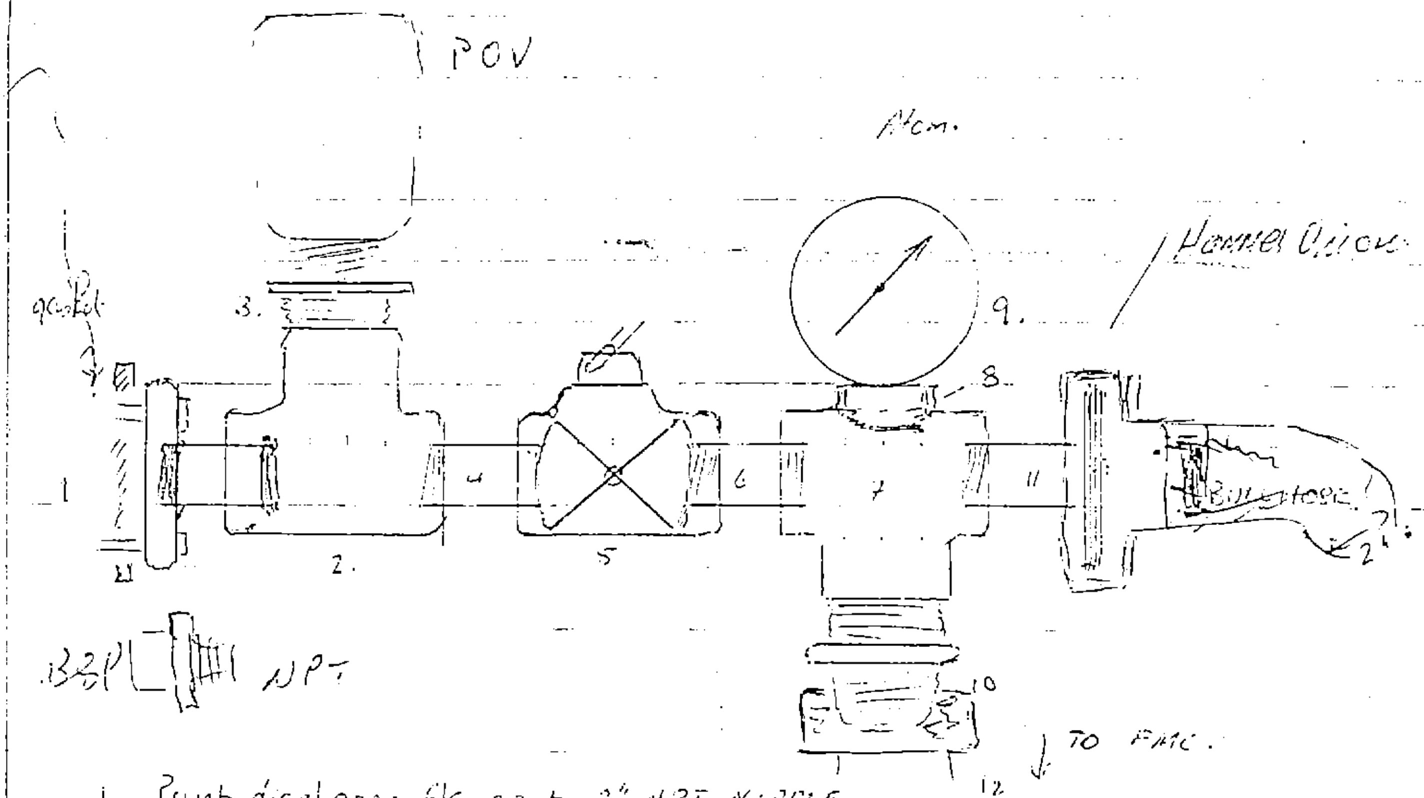
K. Kill Line. 2" NPT kill line assembly (see dia)
2" NPT - 1 13/16 JIC XO Sub.

Note. Spare from Atlem.

Flange Bolts. 24 × 1⅛" Flange assembly bolts & nuts.

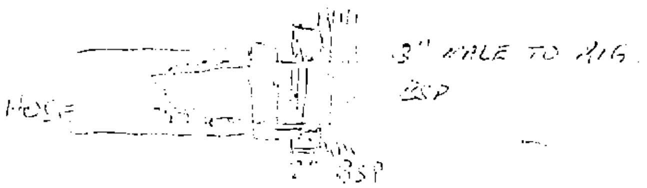
300157

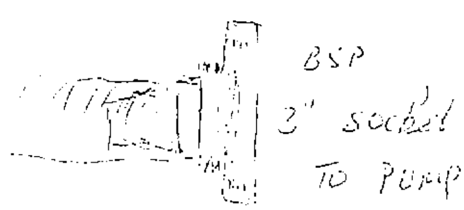
DISCHARGE RATED 1500 PSI



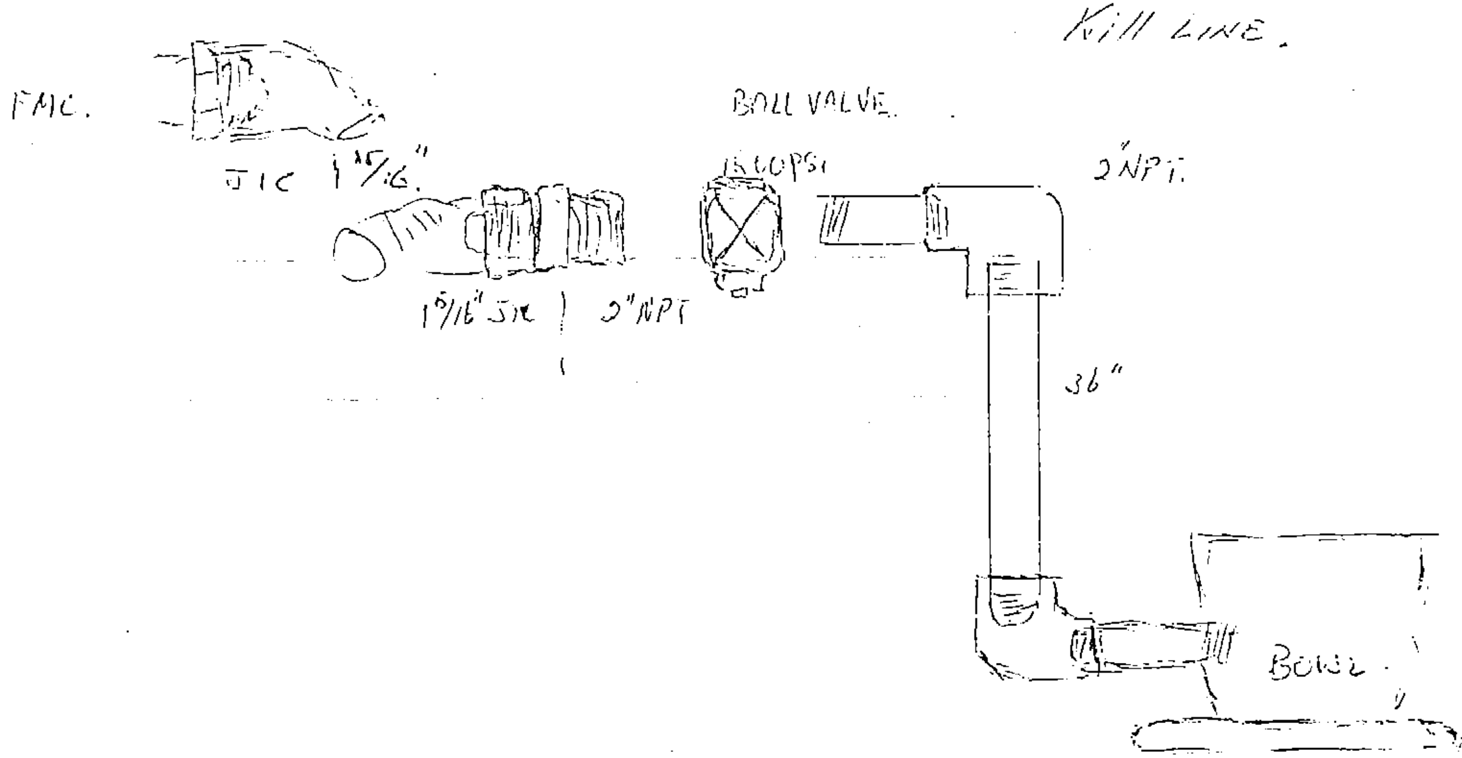
1. Pump discharge flange + 2" NPT NIPPLE.
2. 2" NPT T CONNECTION W/ SURGE CYLINDER.
3. 2" NPT -> SURGE CHAMBER ?
4. 2" NPT NIPPLE.
5.
6. 2" NPT NIPPLE.
7. 2" NPT T CONNECTION
8. 2" NPT ~~NIPPLE~~ - Pressure gauge reduction
9. 1500PSI pressure gauge.
10. 2" NPT - 1 1/16" NIPPLE.
11. 2" NPT -> 3" BSP BULLHOSE NIPPLE.
12. J/C COUPLE HOSE TO FMC PUMP.

Note Bullhose Rasl BSP Rated Fittings.





FMC Discharge = Rated to 1500psi.



1 x General Hydraulics. BOP Closing unit.
2 x ½ Hydraulic Hoses
2 x 1½ WSP (1500psi) ELBOWS.
2 x 1½ WSP - 1⅞" JIC NIPPLE.
2 x 1½" -> 1¼ WSP NIPPLES.
2 x. 1 5/16" JIC - 1" BSP NIPPLES
4 x 1 5/16" JIC 1 5/16 JIC "
1 x 2" [illegible] -> 1" Socket Bull plug x 0

1 x 6000 PSI Pump Pressure Gauge.

Bits 1 x 8½" [illegible]

1 x 1/16" Geol Sieve.
100 x Plastic Sampling [illegible]

3001.59

KILL SHEET — SI UNITS

300160

WELL VOLUMES AND PRE-RECORDED DATA

Annular Capacity (m^3/m) = $\frac{(D^2 - d^2)}{1273240}$ where D = mm ID of hole or casing, d = mm OD of pipe or collars.

Section	D	d	Capacity ×	Length =	Volume

Original Mud Density (kg/m^3) = ________

Measured Depth (m) = ________

Pump #1 Output (m^3/stk) = ________

Pump #2 Output (m^3/stk) = ________

* BOP Stack/Wellhead Rating (kPa) = ________

* Casing Burst Rating (API) (kPa) = ________

* Formation Rating (LOP/PIT) (kPa) = ________

Drill String Volume (m^3) = ________

Full Annulus Volume (m^3) = ________

O H Ann Vol (below Shoe) (m^3) = ________

#1 Slow Pump ________ kPa at ________ SPM

#2 Slow Pump ________ kPa at ________ SPM

PUMP STROKES DATA

Drill String Strokes = Drill String Vol ________ m^3 ÷ Pump Output ________ m^3/stk = ________ stks Ⓐ

Full Annulus Strokes = Full Annulus Vol ________ m^3 ÷ Pump Output ________ m^3/stk = ________ stks Ⓑ

Below Shoe Strokes = Vol below Shoe ________ m^3 ÷ Pump Output ________ m^3/stk = ________ stks Ⓒ

Total Strokes = Ⓐ ________ stks + Ⓑ ________ stks = ________ stks Ⓓ

DATA RECORDED OR CALCULATED AFTER A KICK

SIDPP = ________ kPa SICP = ________ kPa Pit Gain = ________ m^3 TVD = ________ m

KILL Mud Density = $\frac{\text{SIDPP (\qquad) kPa}}{\text{TVD (\qquad) m} \times 0.00981}$ + ( ) kg/m^3 Orig Mud Density = ________ kg/m^3

INITIAL Pump Pressure = SIDPP ( ) kPa + Slow Pump Pressure ( ) kPa = ________ kPa Ⓔ

FINAL Pump Pressure = $\frac{\text{Slow Pump Press (\qquad) kPa} \times \text{Kill Mud (\qquad) kg/m}^3}{\text{Original Mud Density (\qquad) kg/m}^3}$ = ________ kPa Ⓕ

BARYTES MUD WEIGHTING TABLE

Final Dens (kg/m^3)	1100	1200	1300	1400	1500	1600	1700	1800	1900
kg increment	1.349	1.393	1.441	1.491	1.545	1.604	1.667	1.735	1.809

∴ Tot kg reqd = ( ) kg incr × Mud difference ( ) kg/m^3 × ( ) m^3

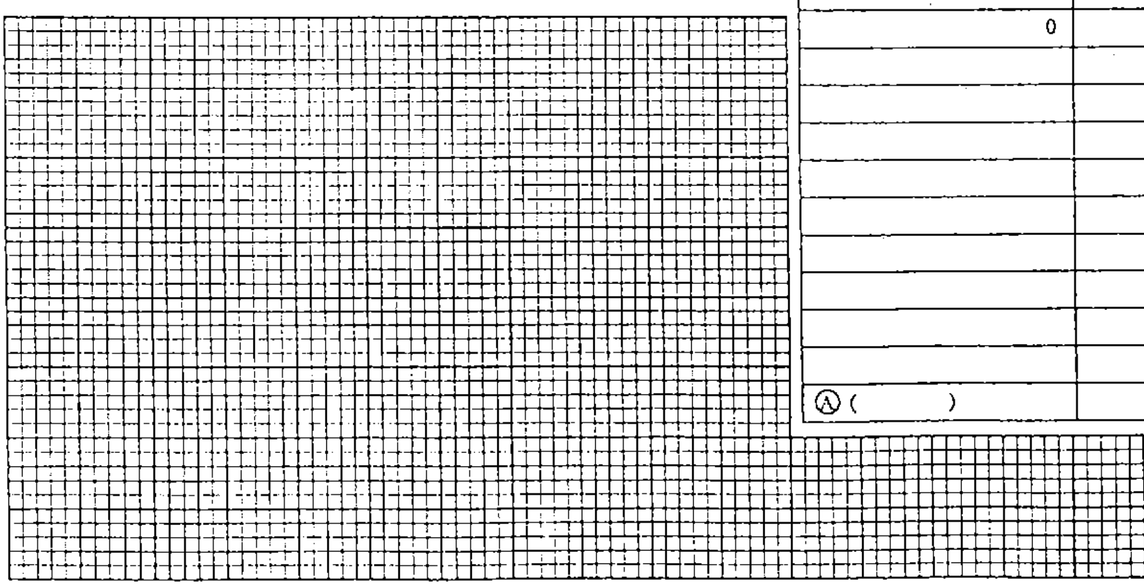
∴ Sacks required = ( ) Total kg ÷ 40 = ( ) sacks

Circulating Casing Pressure (CCP) = SICP ________ kPa − CLFP ________ kPa = ________ kPa.

MAASP ________ kPa, is the minimum of the three pre-recorded pressure ratings* and applies only up to Ⓒ (________) strokes, when the influx is inside casing/liner.

PRESSURE CHART

KILL MUD (STROKES)	DRILL PIPE PRESSURE (kPa)
0	( ) Ⓔ
Ⓐ ( )	( ) Ⓕ



Ⓒ ________ stks
Influx inside casing

Ⓓ ________ stks
Total Strokes

Diamond Core Drilling

Table D3: Physical Properties of Diamond Drill Rods

Rod Size	Nominal OD * ID (mm)	Wall Thickness (mm)	TPI	Coupling Dimension (mm)	Mass kg/m	Rod Capacity litre /10 m	Rod Plug Displacement litre / 10 m
Original Diamond Core Drill Rods							
E	33.3 * 21.4	6.0		11.1	4.17	3.6	8.71
A	41.3 * 28.6	6.4		14.3	5.64	6.4	
B	48.4 * 35.7	6.4		15.9	6.82	10.0	
N	60.3 * 50.8	4.8		25.4	7.28	20.3	
DCDMA 'W' Series Core Drill Rods							
RW	27.8 * 18.3	4.8	4	10.3	2.82	2.6	6.07
EW	35.0 * 25.4	4.8	3	12.7	3.74	5.1	9.62
AW	43.8 * 34.1	4.8	3	15.9	4.91	9.1	15.07
BW	54.1 * 44.5	4.8	3	19.0	6.23	15.6	23.00
NW	66.8 * 57.2	4.8	3	34.9	8.03	25.7	35.05
HW	89.1 * 77.8	5.7	3	60.3	12.66	47.5	62.35
Longyear Wireline Core Drill Rods							
EQ	34.9 * 26.5	4.2	4	26.5	3.20	5.5	9.6
AQ	44.5 * 34.9	4.8	4	34.9	4.63	9.6	15.6
BQ	55.6 * 46.0	4.8	3	46.0	5.97	16.6	24.3
BCQ-Composite	55.6 * 47.6	4.0	3	46.0	5.15		
NQ	70.0 * 60.3	4.9	3	60.3	7.58	28.6	38.5
NCQ-Composite	69.9 * 61.9	4.0	3	60.3	6.56		
HQ	88.9 * 77.8	5.6	3	77.8	11.45	47.5	62.1
HCQ-Composite	88.9 * 80.9	4.0	3	77.8	8.52		
PQ	114.3 * 103.2	5.6	3	103.2	15.26	83.6	102.6
Longyear Composite Heavy Duty Wireline Core Drill Rods							
CHD 76	69.9 * 60.3	4.8	2.5	55.0	9.2 / 8.5	28.6	38.3
CHD 101			2.5				
CHD 134			2.5				

CQ rods have 'Wedge Lok' tapered thread design

Table D4: Longyear W Series Flush Joint Casing to DCDMA CDDA & BSI Standards

Rod Size	Nominal OD * ID (mm)	Wall Thickness (mm)	Coupling Dimension (mm)	Mass kg/m	Rod Capacity litre /10 m	Rod Plug Displacement litre / 10 m
EW	46.0 * 38.1	3.95		4.16		
AW	57.1 * 48.4	4.35		5.64		
BW	73.0 * 60.3	6.35		10.43		
NW	88.9 * 76.2	6.35		12.80		
HW	114.3 * 101.6	6.35		16.83		

Joints with 4 thread per inch coupling supplied in 2 (609.6 mm), 5 (1524 mm) and 10 (3048 mm) foot.

Q-Series, Diamond Bits 300162

SIZE	SET O.D. IN MM	SET I.D. IN MM	A	B	C	D	E	F	G	H	I
AQ	1.875 47.62	1.062 29.97	2.281 57.94	1.937 49.20	1.660 42.16	1.095 27.81	1.437 36.50	1.597 40.56	1.656 42.06	1.835 46.61	0.25 6.35
BQ	2.345 59.56	1.433 36.40	2.625 66.67	2.250 57.15	1.669 42.39	1.469 37.31	1.812 46.02	2.001 50.83	2.063 52.40	2.280 57.91	0.25 6.35
NQ	2.965 75.31	1.875 47.62	2.622 66.60	2.125 53.97	1.125 42.42	1.906 48.41	2.375 60.32	2.597 65.96	2.657 67.49	2.908 73.86	0.25 6.35
HQ	3.763 95.58	2.500 63.50	3.813 96.85	3.281 83.34	1.678 42.52	2.531 64.29	3.062 77.77	3.313 84.15	3.375 85.72	3.711 94.26	0.25 6.35
PQ	4.805 122.04	3.345 84.96	4.627 117.53	4.120 104.65	2.919 74.14	3.408 86.56	4.060 103.12	4.293 109.04	4.386 111.40	4.745 120.52	0.25 6.35
CHD76	2.980 75.31	1.712 43.5	2.810 71.37	2.125 53.98	1.669 42.39	1.802 45.77	2.250 57.15	2.535 64.39	2.595 65.91	2.908 73.86	0.25 6.35
CHD101	3.967 100.76	2.500 63.50	4.000 101.6	3.281 83.34	1.669 42.39	2.590 65.79	3.123 79.31	3.441 87.41	3.566 90.56	3.908 99.25	0.25 6.35

(Courtesy Longyear)

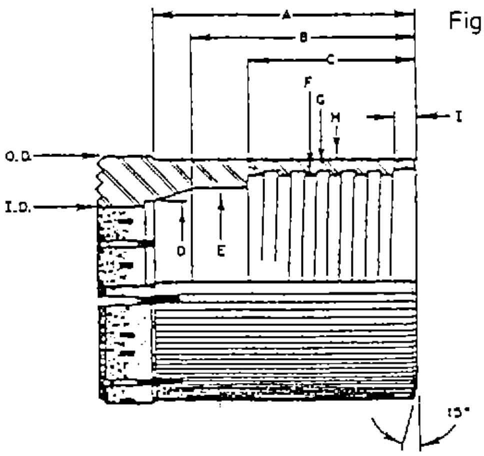


Fig. 4-4 Wireline Bit

Q-Series, Reaming Shell

SIZE	SET O.D. IN MM	A	B	D	E	F	G	H	I	J	L
AQ	1.890 48.00	1.656 42.06	1.597 40.56	1.437 36.50	1.591 40.41	1.651 41.93	1.625 41.27	1.531 38.89	2.397 60.88	6.375 161.92	1.835 46.61
BQ	2.360 59.94	2.063 52.40	2.001 50.82	1.812 46.02	1.996 50.70	2.058 52.27	1.629 41.37	1.531 38.89	2.409 61.19	6.375 161.92	2.280 57.91
NQ	2.980 75.69	2.657 67.49	2.597 65.96	2.375 60.32	2.592 65.84	2.652 67.36	1.625 41.27	1.531 38.89	2.260 57.40	6.750 171.45	2.908 73.86
HQ	3.782 96.06	3.375 85.72	3.313 84.15	3.370 85.60	3.062 77.77	3.307 84.00	1.622 41.20	1.531 38.89	2.910 73.91	7.187 182.55	3.711 94.26
PQ	4.827 122.60	4.385 111.38	4.295 109.09	4.062 103.17	4.288 108.91	4.379 111.23	1.620 41.15	1.531 38.89	1.658 42.11	7.000 177.80	4.743 120.47
CHD76	2.980 75.69	2.595 65.91	2.535 64.39	2.250 57.15	2.530 64.26	2.590 65.79	1.617 41.07	1.531 38.89	2.848 72.34	6.750 171.45	2.908 73.86
CHD101	3.990 101.3	3.566 90.56	3.441 87.39	3.123 79.31	3.433 87.19	3.560 90.41	1.610 40.89	1.675 42.55	2.910 73.91	7.188 182.56	3.928 99.76

Courtesy Longyear

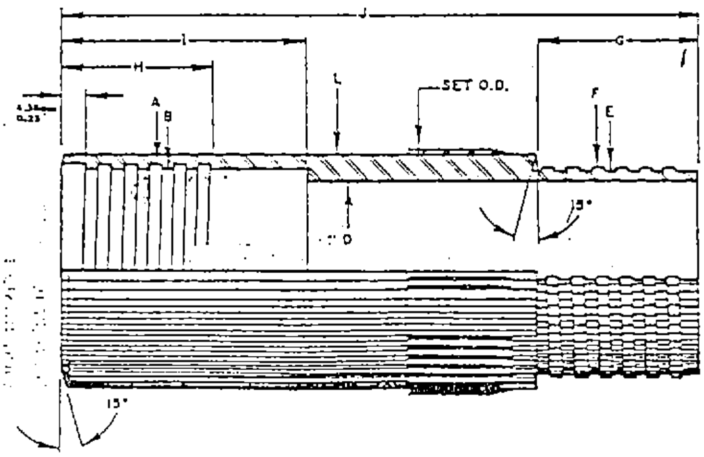


Fig. 4-5 Wireline Reaming Shell

300163

NQ CORE BARREL ASSEMBLY

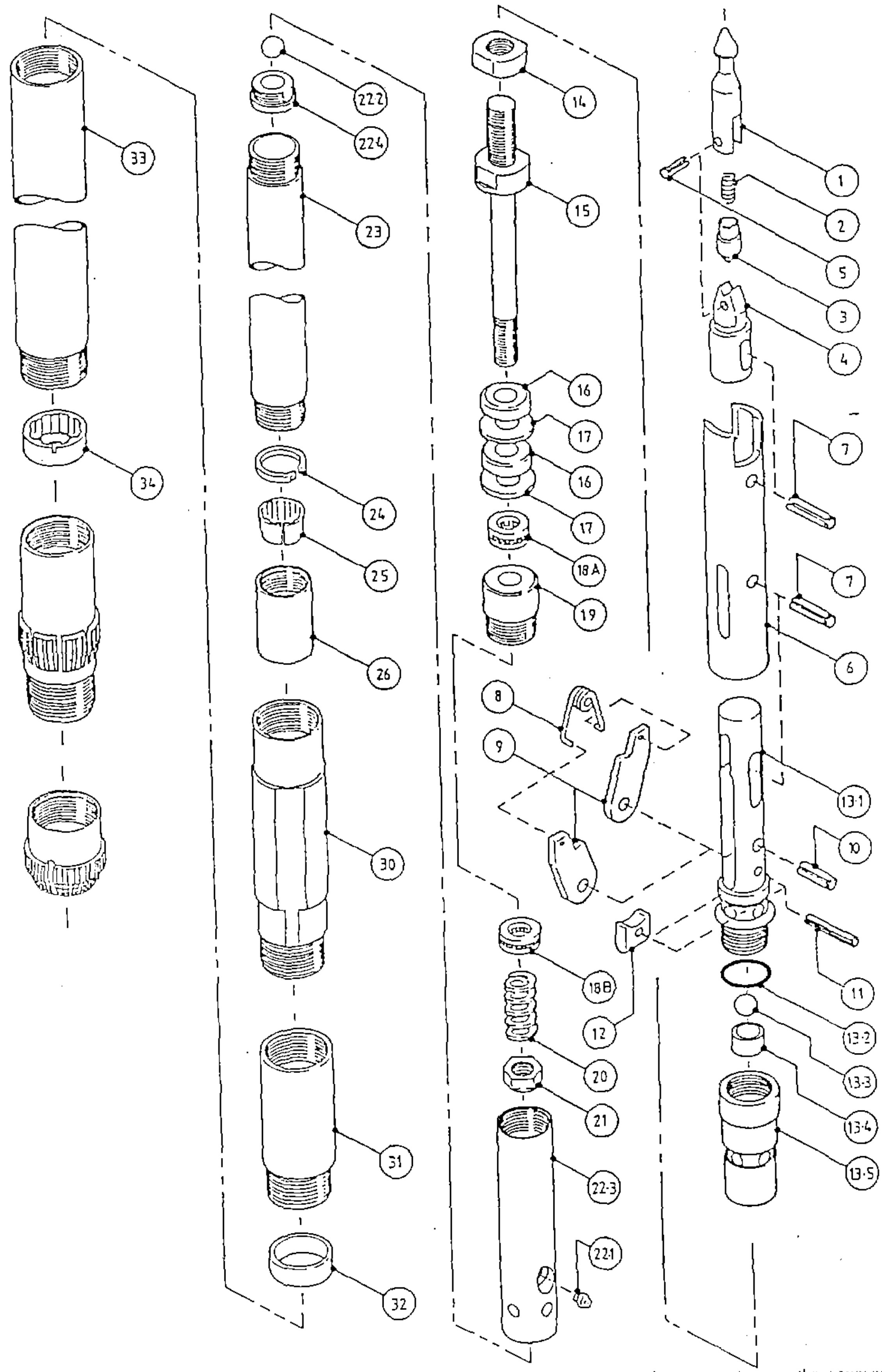
SECTION: 1A
AUSTRALIAN PRICE LIST
EFFECTIVE: 5.6.92
REPLACES: 11.4.91
FOB ADELAIDE/BRANCHES

ITEM NO	PART NO	DESCRIPTION	NO REQD	WEIGHT KG	ADELAIDE	BRANCH
1–35	63509	CORE BARREL ASSY 5FT	1	43.0		1439.55
1–35	63510	CORE BARREL ASSY 10FT	1	62.9		1518.30
1–26	63511	INNER TUBE ASSY 5FT	1	17.1		1001.70
1–26	63512	INNER TUBE ASSY 10FT	1	21.4		1017.45
1–22	63513	HEAD ASSY	1	9.5		829.50
1	42913	SPEARHEAD POINT	1	*		44.00
2	15141	COMPRESSION SPRING	1	*		2.68
3	42914	DETENT PLUNGER	1	*		11.76
4	42912	SPEARHEAD BSE	1	.6		90.51
5	42905	SPIRAL PIN, 7/16" X 1"	1	*		1.52
6	42910	LATCH RETRACTING CASE	1	1.3		116.24
7	24305	SPRING PIN 1/2" X 2"	2	*		3.57
8	44733	LATCH SPRING	1	*		3.52
9	40950	LATCH	2	*		15.49
10	24548	SPRING PIN, 1/2" X 1 1/2"	1	*		2.05
11	22646	SPRING PIN, 1/4" X 1 1/2"	1	*		0.79
12	24883	LATCH SUPPORT	1	*		20.21
13	62625	BODY LATCH NQ IND. ASSY(13-1 TO -5)	1	2.5		336.00
13-1	62626	UPPER BODY	1			238.09
13-2	23676	O RING	1			0.47
13-3	62374	STEEL BALL	1			2.52
13-4	62380	BUSHING	1			18.48
13-5	63324	LOWER BODY(INCLUDES P/N 62380 BUSHING)	1			154.67
14	24885	LOCK NUT	1	*		5.30
15	24886	SPINDLE ASSY	1	1.4		86.05
16	24887	SHUT OFF VALVE	2	*		8.66
16	44209	SHUT OFF VALVE NQ ELAST	2	*		11.29
17	24888	VALVE ADJUSTING WASHER	2	*		9.92
18A	24312	BALL THRUST BEARING	1	*		19.43
18B	18298	HANGER BEARING	1	*		13.13
19	24889	SPINDLE BEARING	1	.7		55.23
20	24313	COMPRESSION SPRING	1	*		16.22
21	24314	SELF LOCKING NUT	1	*		2.57
22	40664	INNER TUBE CAP ASSY(22-1 TO -4)	–	1.5		193.67
22-1	17447	HYDRAULIC GREASE FITTING	1	*		0.58
22-2	25307	STAINLESS STEEL BALL	1	*		5.46
22-3	40677	INNER TUBE CAP	1	1.3		166.15
22-4	37382	CHECK VALVE BODY	1	*		48.98
23	24909	INNER TUBE 5FT	1	5.6		87.05
23	24909CP	INNER TUBE 5FT CP	1	5.6		184.64
23	24891	INNER TUBE 10FT	1	11.1		117.92
23	24891CP	INNER TUBE 10FT CP	1	11.1		291.17
24	24893	STOP RING	1	*		10.08
25	24894	CORE LIFTER	1	*		20.58
25	24894CP	CORE LIFTER CP	1	*		25.67
26	24892	CORE LIFTER CASE	1	*		35.91
30	24895	LOCKING COUPLING	1	2.6		193.10
31	24896	ADAPTOR COUPLING	1	1.6		46.67
32	24897	LANDING RING	1	*		21.11
33	24910	OUTER TUBE 5FT	1	20.0		211.58
33	24910CP	OUTER TUBE 5FTCP	1	20.0		341.04
33	24898	OUTER TUBE 10FT	1	35.9		300.86
33	24898CP	OUTER TUBE 10FT CP	1	35.9		430.40
34	44407	INNER TUBE STABILIZER	1	*		31.55
35	24900	THREAD PROTECTOR	1	1.8		57.59

300164

NQ CORE BARREL ASSEMBLY

SECTION: 1A
AUSTRALIAN PRICE LIST
EFFECTIVE: 5.6.92
REPLACES: 11.4.91
FOB ADELAIDE/BRANCHES



[illegible] products and must, therefore, reserve the right to change designs, materials, specifications, and price without prior notice.

NQ OVERSHOT ASSEMBLY

ITEM NO	PART NO	DESCRIPTION	NO REQD	WEIGHT KG	BRANCH
1-20	68293	COMPLETE OVERSHOT ASSY 6MM	–	15.4	626.85
1	36244	CABLE CLAMP – 6MM	1	*	57.23
2	36243	WIRE ROPE THIMBLE – 6MM	1	*	2.20
3	25991	EYE BOLT	1	*	46.41
4	25990	SWIVEL CABLE COLLAR	1	*	41.32
5	25986	NEEDLE THRUST BEARING	1	*	7.56
6	25985	CASTLE NUT 1/2-20UNF	1	*	1.84
7	44615	COTTER PIN 3/32" X 3/4"	1	*	0.37
8	17447	HYDRAULIC GREASE FITTING	1	*	0.58
9	44444	BODY	1	7.3	189.63
10	44445	JAR TUBE WELDMENT	1	2.8	143.90
11	22917	SELF LOCKING NUT 1/2"-13 UNC	1	*	0.58
12	44448	JAR STAFF	1	1.1	65.26
13	15965	LOCKING SLEEVE**	1	1.6	67.04
14	45582	SPIRAL PIN 1/4" X 1 1/2"	2	*	1.68
15	44442	S/LOCKING S/SCREW 3/8-24UNF X 5/8"	1	*	3.89
16	44449	OVERSHOT HEAD	1	3.3	273.16
17	06951	COMPRESSION SPRING	1	*	1.26
18	42906	PIN 1/2" X 1-15/16"	1	*	5.62
19	14651	LIFTING DOG	2	.5	50.82
20	37394	SPRING PIN 1/4" X 1-3/4"	1	*	0.89

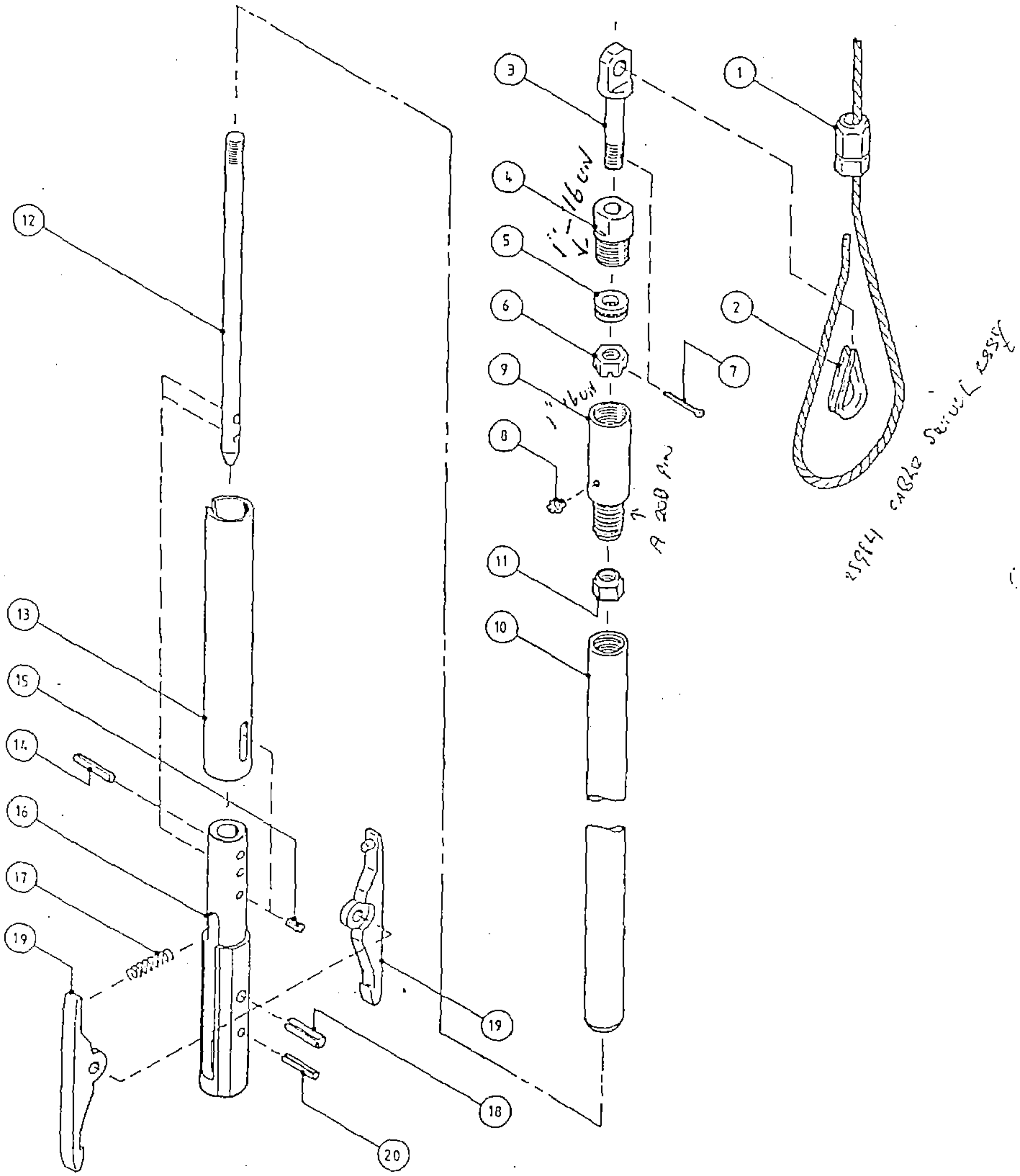
ITEM NO	PART NO	DESCRIPTION	NO REQD	WEIGHT KG	BRANCH
1-20	44443	COMPLETE OVERSHOT ASSY 5MM	–	15.4	626.85
1	25987	CABLE CLAMP 5MM	1	*	57.23
2	25988	WIRE ROPE THIMBLE 5MM	1	*	2.20
3	25991	EYE BOLT	1	*	46.41
4	25990	SWIVEL CABLE COLLAR	1	*	41.32
5	25986	NEEDLE THRUST BEARING	1	*	7.56
6	25985	CASTLE NUT 1/2-20UNF	1	*	1.84
7	44615	COTTER PIN 3/32" X 3/4"	1	*	0.37
8	17447	HYDRAULIC GREASE FITTING	1	*	0.58
9	44444	BODY	1	7.3	189.63
10	44445	JAR TUBE WELDMENT	1	2.8	143.90
11	22917	SELF LOCKING NUT, 1/2" – 13UNC	1	*	0.58
12	44448	JAR STAFF	1	1.1	65.26
13	15965	LOCKING SLEEVE**	1	1.6	67.04
14	45582	SPIRAL PIN 1/4" X 1-1/2"	2	*	1.68
15	44442	S/LOCKING S/SCREW 3/8-24UNF X 5/8"	1		3.89
16	44449	OVERSHOT HEAD	1	3.3	273.16
17	06951	COMPRESSION SPRING	1	*	1.26
18	42906	PIN, 1/2" x 1-15/16"	1	*	5.62
19	14651	LIFTING DOG	2	.5	50.82
20	37394	SPRING PIN 1/4" X 1 3/4"	1	*	0.89

*WEIGHS LESS THAN ONE POUND (.45KG) ** USE LOCKING SLEEVE FOR LOWERING IN DRY HOLES ONLY. IT MUST BE REMOVED WHEN HOISTING INNER TUBE.
NOTE: FOR USE WITH THE KNUCKLEHEAD PIVOTING SPEARHEAD SYSTEM ONLY.

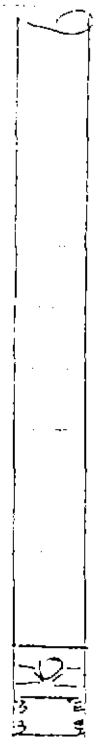
300166

NQ OVERSHOT ASSEMBLY

SECTION: 1A
AUSTRALIAN PRICE LIST
EFFECTIVE: 5.6.92
REPLACES: 11.4.91
FOB ADELAIDE/BRANCHES



HW



VAN RUTH NRV.

275 m.

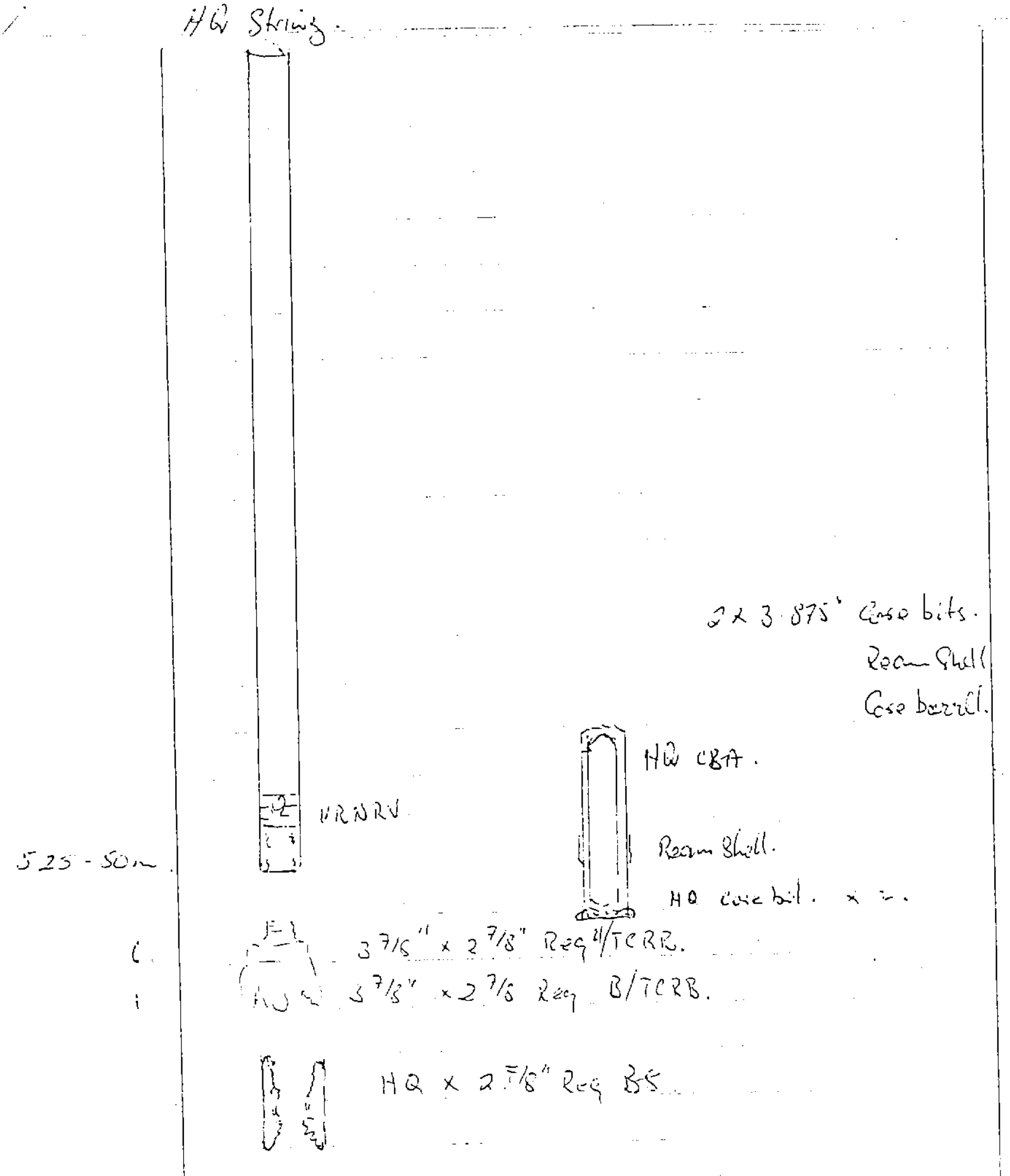
x 3

5 5/8" x 3½" REG Drag bit.
5 ½" x ? Drag bit.

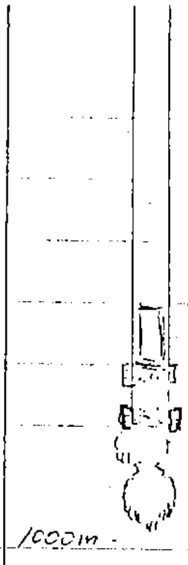
x 6

5½" x 2 7/8" REG TCRB.

HW x 3½" REG BS.
HW x 2 7/8" REG BS.


HQ String.
2 x 3.875' Core bits.
Ream Shell
Core barrel.
HQ CBA.
VRNRV
525 - 50m
Ream Shell.
HQ core bit. x 2.
3 7/8" x 2 7/8" Reg B/TCRB.
3 7/8" x 2 7/8 Reg B/TCRB.
HQ x 2 7/8" Reg BS

Load Out.



NQ Core Rods — ON Rig.

TRY 2 15/16."

NQ CORE BARREL ASSEMBLY

NQ REAM SHELL

NQ CORE BITS

NQ TRICONE BITS 2 15/16" is possible.

1000m

Series 2 NQ requested.

Surface set coarse bits.

6½" Casinghead swivel. (Feares)

6½" Casing cementation head (")

Appendix ⑥

300170

PROGRESS REPORT

ON RESULTS

OF THE

SHITTIM 1.

STRATIGRAPHIC HOLE

CONDOR OIL INVESTMENTS PTY LTD

EL 1/88

MURRAYFIELD, NORTH BRUNY ISLAND

	(- Directors of Condor Oil Investments
Report to	(- Director of Mines
	(- Minister of Mines

Prepared by :- Malcolm Roy Bendall
Managing Director

November, 1994

JERICHO

Unfortunately due to the gas encountered in Gilgal 1 and the re-examination of Shittim 1 revealing gas emanating from that well, the pre-collar of Jericho 1 was not completed due to instructions from the T.D.R.

SUMMARY OF CURRENT POSITION

Two stratigraphic holes were drilled to depths of 51 m and 81 m in north Bruny Island in late November 1994. Condor is very happy to report that gas flowed continuously from both holes and drilling was discontinued for safety reasons. It is Condor's intention to resume drilling with a Blow Out Preventor as soon as one is delivered from Perth. As drilling was stopped following orders from the T.D.R. we would appreciate an extension of the renewal date of our licence by six weeks from the date of installation of the BOP on site.

TABLE OF CONTENTS

FOREWORD

There seems to have arisen a lot of confusion with the T.D.R. over Condor's drilling programme.

This report is written in order to clarify Condor's position.

The Company is very pleased to report that there are continued signs of gas inflow from drill holes on Bruny Island and as a safety precaution we are happy to drill with a BOP as has been suggested by our drillers and the Mines Department and insisted upon by the Company.

Condor has investigated arrangements for a BOP (Appendix 4) and upon approval it will be shipped over as soon as possible.

LIST OF APPENDICES

1. A PROGNOSIS FOR A STRATIGRAPHIC HOLE
   Dr D. E. Leaman, November, 1994

2. HOLE LOGS, INCLUDING SAMPLES (BENDALL, NOV. 1994)

3. HOLE OBSERVATIONS SIGNED BY BENDALL & RICHARDSON

4. DRILLING ENGINEERING (PECTIL, TED McNALLY)

A	-	LETTER	14.11.1994	McNally
B	-	LETTER	15.11.1994	Bendall
C	-	LETTER	29.11.1994	McNally

5. CORRESPONDENCE

A	-	LETTER	A.G.S.C.	11.11.1994
B	-	LETTER	T.D.R.	14.11.1994
C	-	LETTER	M.R. Bendall	16.11.1994
D	-	LETTER	M.R. Bendall	19.11.1994
E	-	LETTER	T.D.R.	21.11.1994
F	-	LETTER	Dr D.E. Leaman	21.11.1994
G	-	LETTER	T.D.R.	23.11.1994
H	-	LETTER	D.J. Bendall	24.11.1994
I	-	LETTER	T.D.R.	02.12.1994
J	-	LETTER	G.R. Garrott	02.12.1994

LIST OF PICTURES

INTRODUCTION

This report outlines the continued signs of gas inflow at near surface onshore Tasmania. Potentially it sets the scene for the establishment of a whole new industry in the State.

As a consequence of extensive scientific research over a 10 year period by various explorers, costing in excess of 3 million dollars, enough data was collected (summary Appendix (1)) to determine the location for a stratigraphic hole onshore Bruny Island.

After a site inspection with the T.D.R. Representatives (Carol Bacon and Dennis Burgess) on 17 November, the prerequisite requirements were stated. These requirements were addressed by my letter of 19 November, 1994, and the first hole, Shittim 1, was commenced on 21 November by K.M.R. Drilling.

To ensure a good start to the hole, a five and a half inch rock hammer was used, as a good pre-collar increases the chances of successful completion to total depth.

It was intended to pre-collar the first 100 metres of the hole prior to drilling NQ to 1000 metres.

INTRODUCTION

The correspondence from the T.D.R., dated 23 November, 1994, confirms "*The hole is to be diamond drilled at core size H or equivalent* pre-collar near surface", confirming Dr David Leaman's advice in his letter of 21 November, 1994. (Appendices 5E and 5F)

Whilst the rig was set up to pre-collar, it was thought prudent to put down the first 100 metres of Gilgal 1 and Jericho 1, so as their casing could be concreted in and set before drilling re-commenced. As is outlined further in the Report, due to gas inflow to Shittim 1 at 60 metres and gas inflow to Gilgal 1 at 50 metres, the pre-collar for Jericho 1 (figure 1) was abandoned. This was at the advice of the Registrar of Mines, this verbal instruction (Appendix 5 H) being confirmed by later advice in a letter of 28.11.1994 (Appendix 5 I). The rig which was moved off site and stopped drilling, clearly has the capacity of coring N Q size as per Appendix 1 specifications, the intention being to core to 500 metres then swap to a greater capacity rig. The driller has a first option on the greater capacity rig, which subject to approval is scheduled to be on site in early December, 1994, on target for December 31st completion date.

Drilling records, sampling and detailed accounts of the two holes are included in this Report.

INTRODUCTION

Condor Oil is anxious to continue on its programme and is awaiting clarification of the Departments new requirements.

DRILLING

SHITTIM 1

The location of Shittim 1 (Figure 1) was determined by Dr David Leaman through examination of geological, geochemical, geophysical and topographical data.

Appendix 1 outlines his logic for siting the hole and was accepted as a legitimate position for a stratigraphic well by the T.D.R. (Appendix 5, 14.11.1994) on their visit to the site on Thursday, 17 November, 1994. On that visit a further letter from Dr David Leaman was requested (Appendix 1B) as well as other requirements including copies of notification of the land owner which was covered in my letter dated 19 November, 1994.

Having covered all statutory requirements, the rig was shipped onto Bruny Island on the 9.30 am ferry and was located on site (Picture 1) 30 metres above sea level and drilling by 12 noon on Monday, 21 November, 1994 (Picture 1). Six and one half inch casing was set to 2.5 metres by 12.30 pm (Picture 2) and drilling ceased at a total depth of 81 metres (Diameter 5 1/2 inches) at 4.30 pm, Tuesday, 22 November, 1994.

The hole was dry for the first 64 metres until hot brine returned at a rate of 7000 gallons per hour with a distinctive strong odour (Picture 3.) The drill dropped about .3 metre into a cavity at this point and hit numerous calcite line cavities further down.

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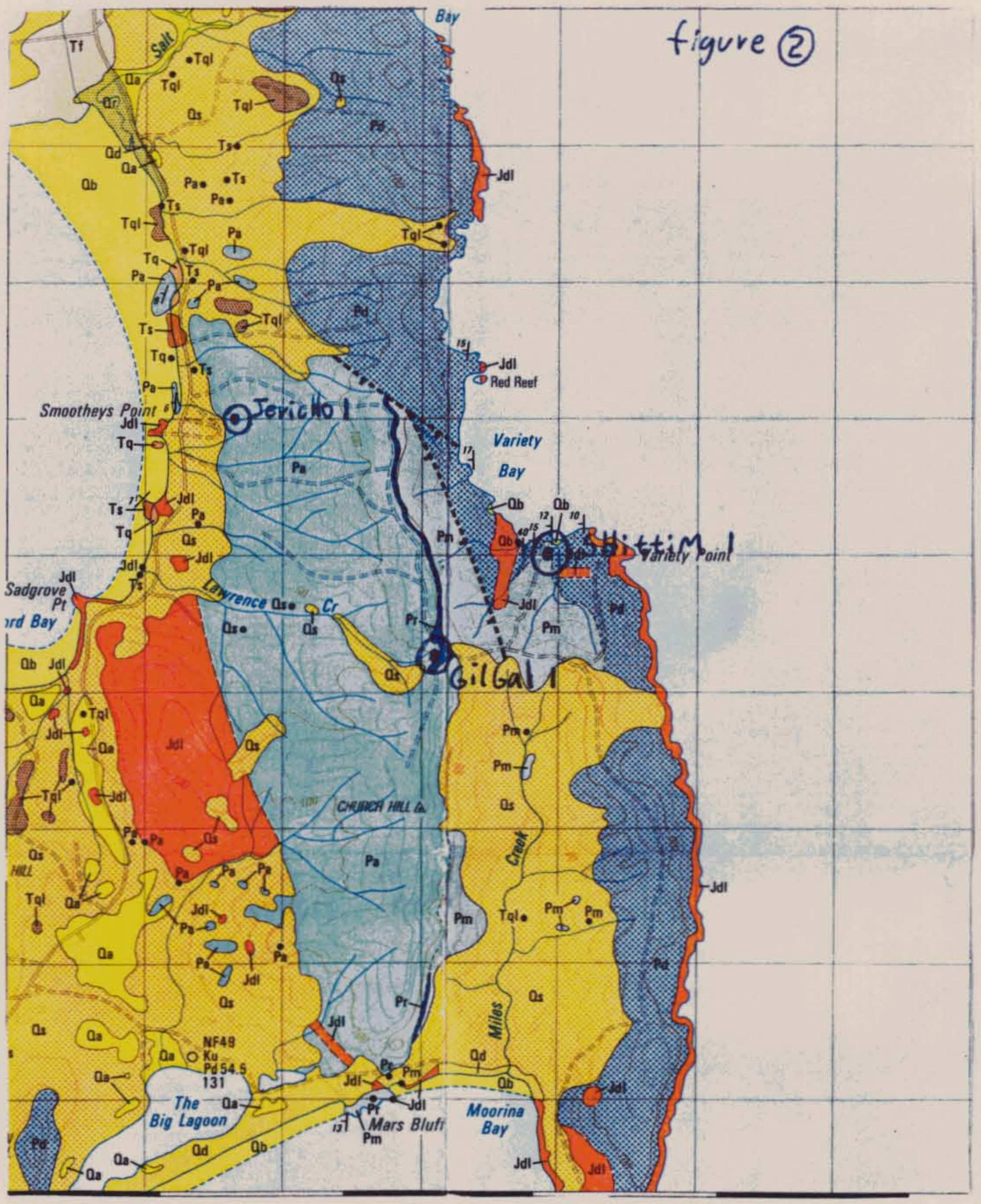
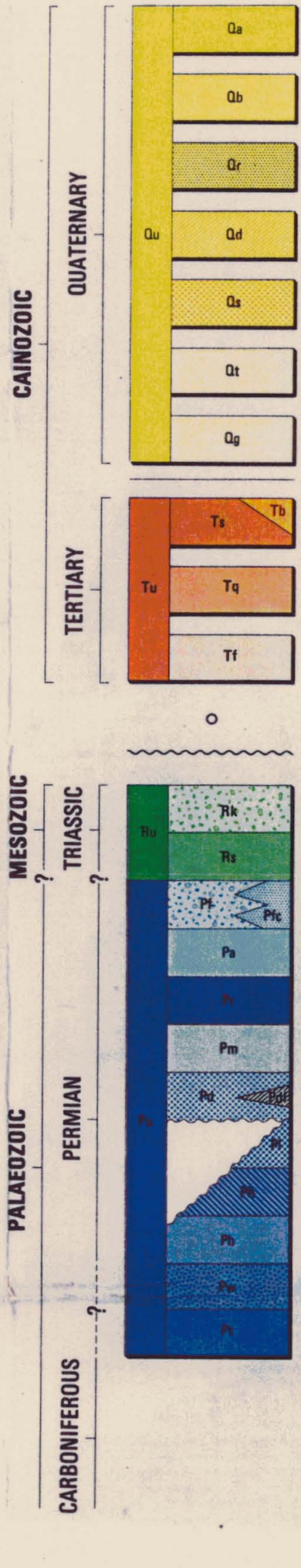


figure ②
Bay
Salt
Tf
Tql
Qs
Qa
Qd
Qb
Ts
Pa
Tq
Pd
Jdl
Red Reef
Variety
Bay
Smootheys Point
Jericho 1
Shittim 1
Variety Point
Sadgrove
Pt
rd Bay
Lawrence
Cr
Pm
Pr
Gilgal 1
CHURCH HILL
HILL
Creek
Miles
NF49
Ku
Pd 54.5
131
The
Big Lagoon
Mars Bluff
Moorina
Bay

300182

figure (2)

REFERENCE



Alluvium, river terrace deposits, lagoon deposits, and sand (Qas) at Cradoc (EN 025280).

Beach and tidal flat deposits.

Raised beach deposits.

Stable and mobile dune deposits.

Blown sheet sand deposits; with underlying consolidated sand (Qsc) at South Arm (EN 401389).

Scree and talus — predominantly dolerite (Qtd) : predominantly Syenite (Qts) : predominantly Lower Parmeener rocks (Qtp) at (EN 020380): predominantly Triassic (Qtt) at (EN 081377).

Gravel and boulder beds — predominantly siliceous clasts (Qgs) : predominantly dolerite clasts (Qgd) .

Erosional surface.

Basalt and associated pyroclastic rocks; where indicated by Quaternary lag (Tbl) .

Dominantly clay, sand, gravel.

Silicastone (greybilly and silcrete?); present as outcrop Tq; where indicated by Quaternary lag (Tql) .

Ferricrete; present as outcrop (Tf): ferricrete derived from Tertiary dolerite boulder beds indicated (Tfd) .

Ku: Undifferentiated Cainozoic sedimentary rocks in Bruny Island bore at (EN 313123).

Low Angle unconformity.

Kaoota Coal Measures — dominantly feldspathic and lithic sandstone with subordinate mudstone and thin workable coals. Contains a Triassic flora.

Dominantly medium –, coarse – grained quartz sandstone with subordinate mudstone and minor clay-pellet beds.

Dominantly feldspathic sandstone with subordinate mudstone (Pf): with workable coals and a Permian flora, Cygnet Coal Measures (Pfc).

Abels Bay Formation — siltstone, sandy siltstone, and minor sandstone beds with frequent dropstones and occasional fossil horizons.

Risdon Sandstone — coarse – grained feldspathic sandstone, granule – and pebble-conglomerate.

Minnie Point Formation — very variable fossiliferous marine siltstone and sandstone with many dropstones and much glacially derived sand grade material.

Deep Bay Formation — interbedded, highly fossiliferous, marine mudstone, siltstone and sandstone with many dropstones. A thin lens of impure limestone (Pdl) occurs at Silver Hill (EN 021233).

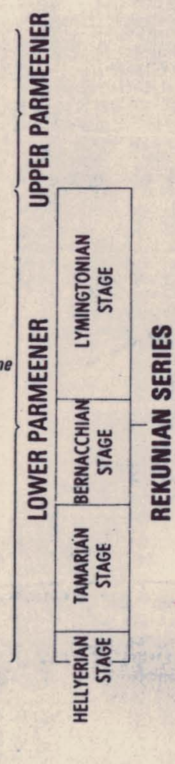
Harts Hill Limestone — highly fossiliferous marine bioclastic limestone with some dropstones.

Hickman Formation — dark-grey, fossiliferous, marine mudstone and siltstone layers usually rich in the brachiopod Cancrinella.

Bundella Mudstone — monotonous, fossiliferous, marine mudstone and siltstone layers with numerous dropstones.

Woody Island Siltstone — dark-grey, poorly-bedded, sparsely fossiliferous, friable, glendonitic siltstone.

Truro Tillite — tillite with occasional beds of black, pebble-free mudstone.



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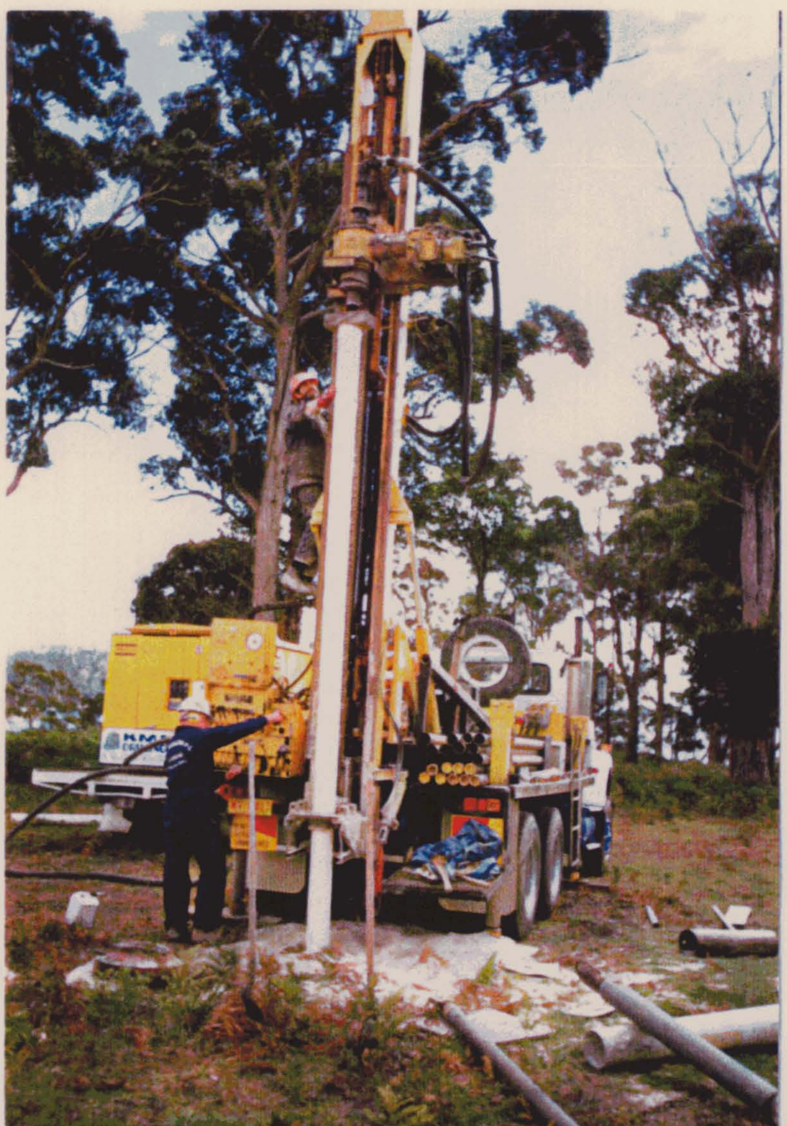

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(3)

(4)

DRILLING

SHITTIM 1

The weight of the water slowed the progress of the hole considerably along with pervasive silicification, it taking 45 minutes to complete the last three metres of the hole.

An increase in the odour at the same time precipitated the decision to abandon the hole. Appendix 2 and 3 summaries the hole geology, sampling and observations whilst drilling.

Subsequent to the rush of gas into Gilgal 1, the Shittim hole was re-examined. It was found that flammable gas was escaping from the hole, bubbling down the hole being plainly audible for the first three days accompanied after that by a clear hissing noise from gas escaping from strata above the water table of the hole.

The hole is capped with a 150 mm top fitted with a pressure gauge and the immediate area around the hole fenced off with plastic safety fencing.

Picture 6 illustrates apparatus which will be used to sample the gas.

Picture 7 shows it working, this method was used to establish that the gas was flammable.

Pictures 8 and 9 illustrate the discolouration of the polypipe caused by the condensing of the gas fraction

(5)

(6)

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SAMPLING OF SHITTIM 1

Rock chip samples were taken at three metre intervals in Shittim 1. These will be split and delivered to the T.D.R. Water samples were taken on site (Picture 3) and delivered to the C.S.I.R.O. Marine Laboratory for salinity, pH and geochemical tests, the results of which should be available shortly. Preliminary results on the geochemistry however, indicated the presence of a heavy diesel fraction with biomarkers consistent with middle eastern crudes in the brine in the trace amounts. Large rock samples recovered during drilling indicate high porosities and permeabilities in the rock consistent with the flow of 7000 gallons per hour of water.

Tony Yeates of The Australian Geological Survey Organisation (A.G.S.O.) is sending down gas sampling devices so as the exact nature of the gas emanating from the hole can be determined. Further testing by A.G.S.O. in these holes is possible in the near future.

SHITTIM 1

FURTHER WORK TO BE COMPLETED

H W Casing will have to be set to the pre-collar total depth of 81 metres and cemented between the casing and the country rock to establish a solid base for the annular preventor. The portable cellar concrete slab compacted gravel area, mud pits etc. Prescribed by Ted McNally and detailed to Hazell Bros. will have to be completed.

Appendix 4 includes pictures of the annular preventor with portable cellar Condor oil has secured and which was used on a similar stratigraphic well in Western Australia.

Once the BOP is fitted to the H W Casing the hole can be cored at NQ to 1000 metre.

DRILLING

GILGAL 1

The location of Gilgal 1 was chosen because it was in a similar geological position to Shittim 1, being some 400 metres off structure, see Figure 1 and 2. The similarity of structural position to Shittim 1 was important as although it is completely different geology to that encountered in that hole, it should be unlikely to encounter a reservoir in that hole and as such was a logical site for a second stratigraphic hole.

Jericho 1 was chosen by the same logic, all the holes were not expected to encounter hydro carbon reservoirs and, in fact, are still not, the shows to date being low pressure surface phenomenon possibly cutting hydrocarbon and brine migration paths updip.

The hole was commenced at 8.40 am, Wednesday, 23 November, 1994, and drilling to a total depth of 51 metres was completed by 4.30 pm the same day.

The hole was cased to 2 metres with 150 mm polypipe, the remainder of the hole being drilled by a 5 1/2 inch hammer. The hole was drilled very fast, 42 metres having been achieved by 11.55 am, 3 hours and 35 minutes after commencement, in excellent competent ground conditions.

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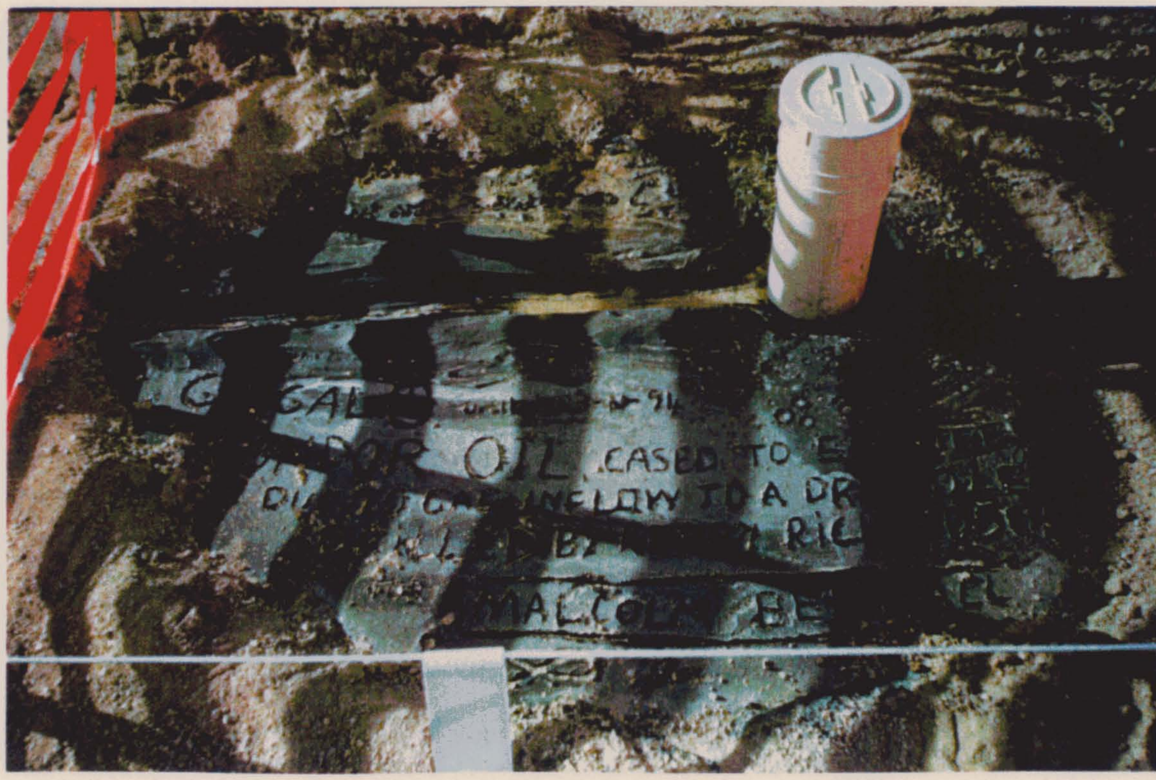
(11)



DRILLING

GILGAL 1

Moist, clayey fractured conditions started at 42 metres and continued on until the total depth of 51 metres. The last 9 metres was only achieved by introducing water and foam into the hole to establish some sort of return from the hole.

The hole was completely flushed twice with water before the drill rods were withdrawn.

The rods were withdrawn some 71 minutes after drilling ceased, a mirror was used to lock into the hole, clouds of gas were observed swirling up the hole and upon listening to the hole, a loud hissing noise was evident, a strong odour accompanied the occurrence.

The rig was moved on to the site of Jericho 1 ready to commence pre-collaring. Expert advice was sought as to proper procedures to control the gas inflow to Gilgal 1. A water truck was subsequently found to fill the hole and kill the gas flow. It stopped the gas, boiling the water about two meters from the top of the hole and only bubbling and effervescing at the top. Grade 9 high pressure 100 mm poly pipe was installed the next morning and concrete was poured between it and the country rock effectively stopping the gas flow. A cap was installed on the 150 mm casing with a pressure gauge and a safety fence was erected around the hole.

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DRILLING

GILGAL 1

The hole flowed gas at a low rate, a high pitched whistle being clearly audible down the hole for 2 days after cementing. The hole started sucking on Sunday, 26 November, 1994, however, by Monday, 27th, was again blowing gas, the smell of the gas is quite distinct from that of Shittim 1., it having an indescribable musty smell opposed to the acid acrid smell of the gas in Shittim 1. Appendices 2 and 3 summarise the hole geology, sampling and observations whilst drilling.

SAMPLING OF GILGAL 1

Rock chip samples were taken at 9 metre intervals as the geology seemed fairly consistent down the hole. These samples will be split and delivered to the T.D.R. Water samples, from the water recovered by filling the hole to surface level the third time, were sent to the C.S.I.R.O. for salinity, pH and Biomarker analysis. The clay which caused drilling problems in the bottom of the hole was found to be immimissible in water, it was recovered from around the top of the rock hammer, it had a very strange indescribable acrid musty smell and was sent off to the C.S.I.R.O. for analysis. Initial results indicate a UCM of heavy crude from 25 onward. Further tests on the biomarkers of this are being completed. A.G.S.O. gas sampling equipment is also being sent down by Tony Yeates so they can sample it and determine its composition. A.G.S.O. may also do further tests on the hole to obtain further geological information. Picture 13 shows the apparatus which will be used to sample the gas once containers arrive.

GILGAL 1

FURTHER WORK TO BE COMPLETED

This hole is cased with 100 mm high pressure polypipe to a depth of 51 metres (T.D.) H Q casing can be set and concreted inside this pipe to 100 metres before drilling on a 1000 metre NQ cored stratigraphic hole.

CONDOR OIL INVESTMENTS

NORTH BRUNY ISLAND

A PROGNOSIS FOR A STRATIGRAPHIC HOLE

INTRODUCTION

The well defined and described in this prognosis is the first well to be drilled by Condor Oil Investments in Tasmania.

The site chosen stands above Variety Bay on the eastern coast of North Bruny Island and overlooks Storm Bay. See Figure 1.

Location: 533 900 mE
5215 000 mN
~25 mASL

BACKGROUND INFORMATION

Petroleum products have been reported on North Bruny Island for several decades and active exploration was undertaken more than sixty years ago.
Several wells have already been attempted in the Great Bay and Big Lagoon region. All have been limited by the funds and equipment available. The details of this drilling and the companies involved were described by Bendall (1991).

The most important of these wells was Johnstone's Well drilled in 1929. The site is shown in Figure 1. Although it reached a depth of less than 50 m and no reliable records of formations or hydrocarbons encountered have survived some oil was recovered. It was a light oil and was stored in drums at the site. It was not analysed and none has been preserved. Its source is unknown. The well did not penetrate deeply into the Permian succession due to jamming.
The deepest drilling in the area, at the north end of the isthmus, was to 135 m and this does not appear to have encountered the thick dolerite sheet which could have been expected at this approximate depth.
Any hydrocarbons found in the area, or these holes, must have drained from, or through, the Deep Bay and, more probably, the Minnie Point Formation which includes porous sandstones.
A number of other seepages have been reported in this same general area and all occur in rocks at about the stratigraphic level of the Minnie Point Formation. All these units are Permian in age. Many of these seepages, and tar coatings, have been found around Variety Bay.

The knowledge of this old drilling programme and the company behind it was forgotten for nearly sixty years. As were the seepage reports.

Exploration was renewed by Conga Oil in 1984. The new exploration incorporated an initial literature search and relocation of reported seepage sites. The site of Johnstone's Well was found and samples taken of muds, soil and local fluids. These confirmed the trace presence of hydrocarbons and the chemistry was consistent with a source within the Ordovician Gordon Group limestones of southern Tasmania. Unfortunately the trace amounts recovered do not permit any definite conclusions or complete appraisal of the oil - as might a small jar of the actual oil.
The exploration was expanded to include regional gravity and magnetic surveys (Figures 2, 3) which were interpreted to suggest that possible source rocks may exist to the west and southwest but were most unlikely beneath North Bruny Island itself (Figures 5, 7). This was essentially confirmed by the trial seismic traverse along the ridge from Trumpeter Bay to Church Hill (Figure 4). The geophysical analyses were primary and regional but did provide an understanding of the setting of the region, possible locations of critical structures and older basins, and a context for migration paths (Figure 6). Some work was begun to crystallize the detailed local setting of North Bruny Island but this work was never funded nor completed. Samples of the initial analyses are reproduced in Figures 8 and 9 and this incompleted evaluation provides the information used for location of the present well proposal. Complete details of the status of exploration studies (geophysical and geochemical) actually completed may be found in Leaman (1990, 1991 and Carne, 1992).
There remains scope for much more work but further work would be enriched by some new control information; including depth to basement and seismic velocities.

The seepages recorded in the area can be understood in terms of the structures described regionally. A reservoir to the west, sealed by the base Permian unconformity, may leak up dip to the large dolerite feeder near Ford Bay or the faults marginal to Storm Bay which were reactivated throughout the Tertiary. Given the thermal history of the region it is possible that actual generation did not commence until the Cretaceous and may still be occurring (see Carne, 1992).

Earlier drilling programs may have intersected some near surface migration paths. As would the newer fault fracture systems. All leakage appears to occur slowly and there is no evidence of any high pressures. The association of seepages with seismic activity also suggests a tight, low volume system above the unconformity or seals.

Consequently any new well drilled in the North Bruny region must have a conceptual or stratigraphic basis with the direct aim of further sampling any migration paths and confirmation of sequence.
Such a well would provide proof that oil is indeed migrating through a viable fracture net and that either generation is continuing or that there may be a large reservoir nearby. A reasonable sample would also resolve many of the source and generation issues since it would allow exhaustive chemical analysis.
These are the primary objectives of this well.

HISTORY OF PROPOSALS

Conga Oil proposed re-drilling of the Johnstone's Well site in 1987 in order to prove the veracity of the old records, obtain a small sample and complete chemical appraisals. The recovery of even a small sample from a fracture or bedding seepage would also have been of considerable financial benefit to both the project and the company since it would have established that parts of Tasmania do have petroleum potential - a possibility that had been long dismissed in both large company and government circles and whose attitudes made financing of the exploration difficult indeed. The company itself had sufficient confidence in the project to employ a drilling engineer, review used equipment in North America, and to purchase a rig with a capacity in excess of 2500 m. This equipment was never imported into Australia for reasons beyond the scope of this prognosis and became the source of considerable financial loss to the shareholders.

Drilling of the site was again proposed in 1991 (Bendall, 1991).

Final stage evaluation of the geophysical and structural information available, however, did indicate that the Johnstone's Well site may not provide an optimal stratigraphic section. The nearness of a dolerite feeder and the risk of thickened dolerite coupled with a higher stratigraphic level meant that any hole at the old site may be several hundred metres deeper than one across the hill. This issue became important to the company felt the loss of its own drilling equipment and funding became more restricted in the 1990-1993 period .

WELL PROGNOSIS

Any drilling programme is dependent on the exploration undertaken and in this case only limited regional analysis has been completed.
Site selection has been judged, therefore, on the basis of minimum depth to basement (in order to establish the stratigraphy of the region), the loci of seepages (in order to maximise opportunities to sample the migration path) and good drilling conditions.

No formation older than the Deep Bay Formation outcrops on North Bruny Island and the site selected lies near the top of this formation.

The prognosis for the well is

Surface to 20 m	Minnie Point Formation	sandstone/siltstone
20 - 50 m	Deep Bay Formation	foss. mudstone
50 - 400 m	dolerite	
400 - 450 m	Deep Bay Formation	foss. mudstone
450 - 550 m	Bundella Formation	foss. mudstone
550 - 700 m	Woody Island Siltstone	mudstone
700 -1000 m	Truro Tillite	tillite
unconformity		
1000 -	Precambrian schists	

Some key unknowns are included in this prediction.
a) Thickness of dolerite. 350 m is an average estimate.
b) Only one dolerite sheet is presumed. Two are possible but a basal sheet may be relatively thin.
c) Thickness of tillite. This may vary from nil to 700 m.
d) Thickness of the Deep Bay and Bundella Formations. The estimates are representative of local formations but a variation of up to 50% is possible.

Items c) and d) depend upon the location of this site with respect to the basin deposition axes. All formations older than the Minnie Point Formation may occupy active rift stages and their thickness thus depends on the location of this site with respect to the block rotation of the rift. Insufficient work has been completed in southern Tasmania to establish this with certainty but if older structures have been rejuvenated then it is possible that this eastern location is comparable with Glenorchy where the tillite was absent.

Hydrocarbons seepages could be encountered at any level and very careful monitoring of fluorescence within the core recovered will be essential. The site itself has been selected with regard not only to the position of exposed faults disturbed along the Storm Bay coast during the Tertiary but also the likely Jurassic disposition of faults - several of which are either no longer exposed or disguised by intrusions. A comparison of Figure 8 and the regional geological map of the area (Kingborough) will indicate some of these differences. The surface geological map is not, in itself, a reliable guide to fracture foci or faults. The coalescence of structures east of Church Hill and south of Variety Bay may well account for the number of small seepage sightings in this part of the island.

The well will also be used for seismic velocity tests in order to permit review and reprocessing of seismic data.

WELL REQUIREMENTS

Type of well:
Two types of petroleum-related wells may be defined (e.g. Carne, 1991):
1. Exploration well (wildcat) is one drilled to discover whether previously untested trap conditions contains oil or gas, and
2. Stratigraphic well drilled solely to obtain subsurface information on sediments, structure, organic maturity and provide control for geophysical purposes.

The proposed well falls within the second category.

No specific target or source is proposed; indeed, all regional work suggests that the primary target for wildcat drilling lies several kilometres to the west.

The well will be a small diameter diamond hole ('N') which will be continuously cored (a shallow pre-collar may be prepared - option).

A diamond hole to a depth of 1000 m needs few special requirements beyond those normally specified for control of drilling fluids, access and landholder compensation.

Comments on equipment experience:
The history of all previous drilling of this type within Tasmania supports this view. No Mines Department diamond drilling has ever required any special equipment, including the 1000 m hole at nearby Woodbridge. No problems have ever been encountered with high pressure hydrocarbons including the Douglas River hole drilled by the department, and which is still flowing gas. Other drilling in regions with oil shale, whether for the shale or for groundwater, have ever posed pressure problems. The much deeper mineral exploration holes in western Tasmania have, likewise, not presented any experience of problem conditions even though gas risks may increase with depth in any basement type.
The Variety Bay area is not noted for large seepages, or very gassy ones, and there is no ground for any expectation of incidents. The load of a full drill stem in a limited diamond hole is clearly safe given all past experience. Were special regulations to be imposed on this hole, as has been suggested to the company, then this company would respectfully insist that they should also be applied to every water bore in Tasmania and all mineral holes in western Tasmania as well. It would also ask why government drilling did not operate to comparable standards.
Quite different requirements might well apply to a hole aimed directly at a fully investigated petroleum reservoir structure drilled using standard exploration open hole mud-control methods. This is not such a hole.

Detection of hydrocarbons:
It is expected that fluoresence methods will be required to detect any hydrocarbons in the hole/core since no large flows are anticipated in any formation given the seepage styles and seismicity relationships.

HOLE NAME

The name designated for this well is SHITTIM-1.

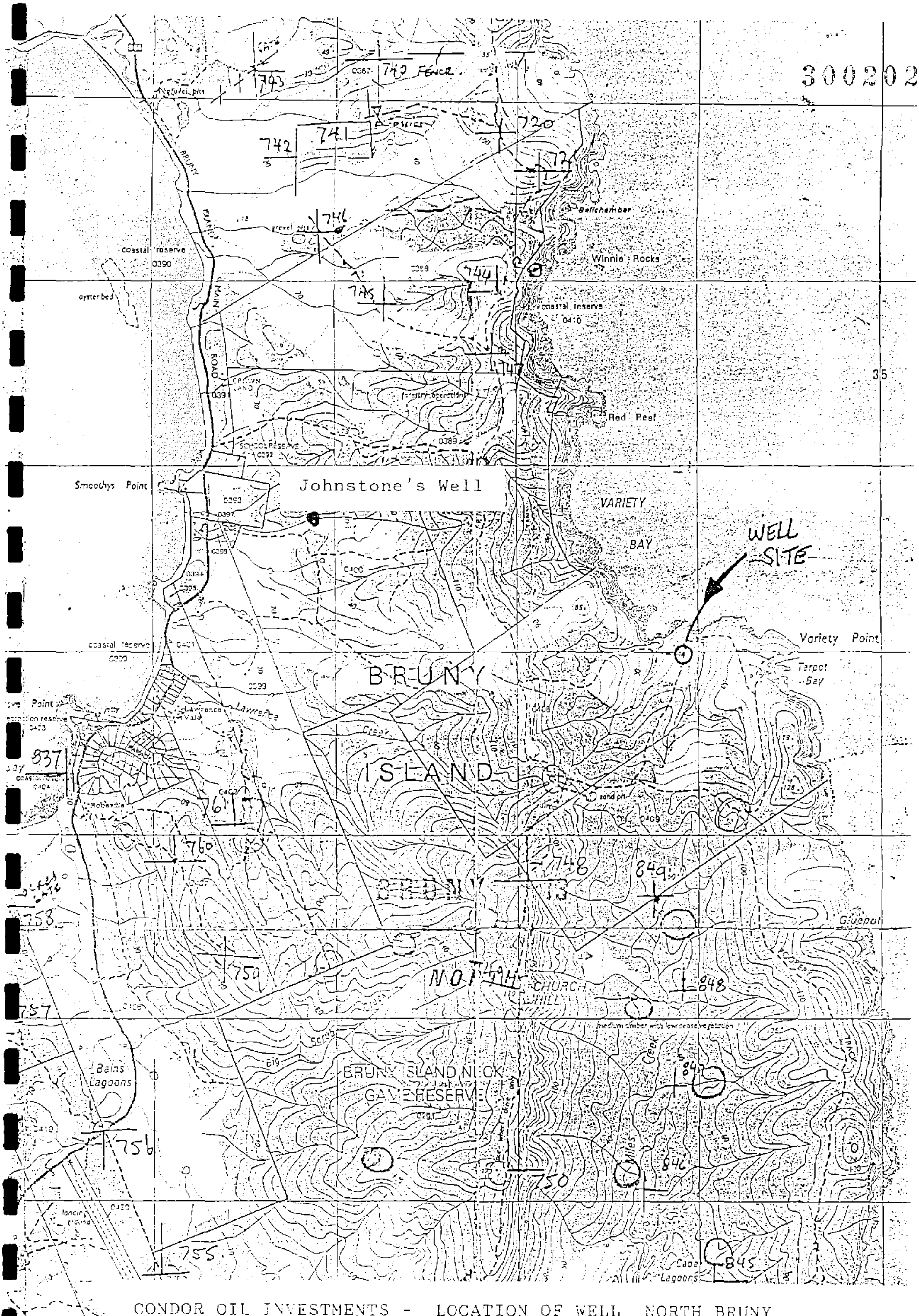
This name has a number of important connotations - for both the company and the area.

The name has historical significance as the place where both a new start and a turning point was achieved. This is clearly what is hoped for on North Bruny and for the company. It might also mean a new start for the way in which this state is viewed by petroleum explorers. It is also the name of an attractive tree whose relatives are common in this country and which produces a useful light oil.

Prognosis submitted on behalf of Condor Oil Investments

by C. N. Leaman
Leaman Geophysics 19/11/94

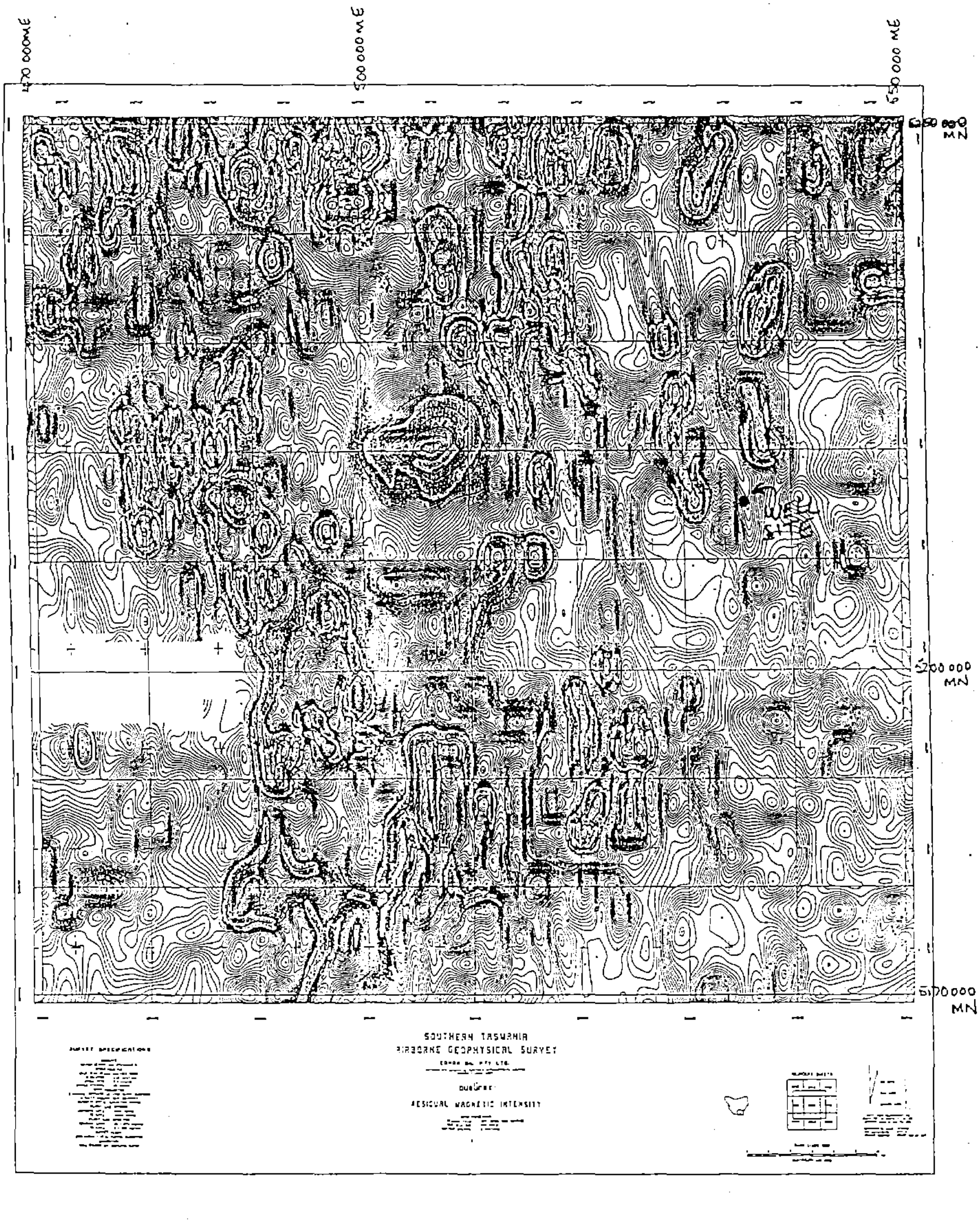
300202



CONDOR OIL INVESTMENTS - LOCATION OF WELL NORTH BRUNY ISLAND

FIGURE 1

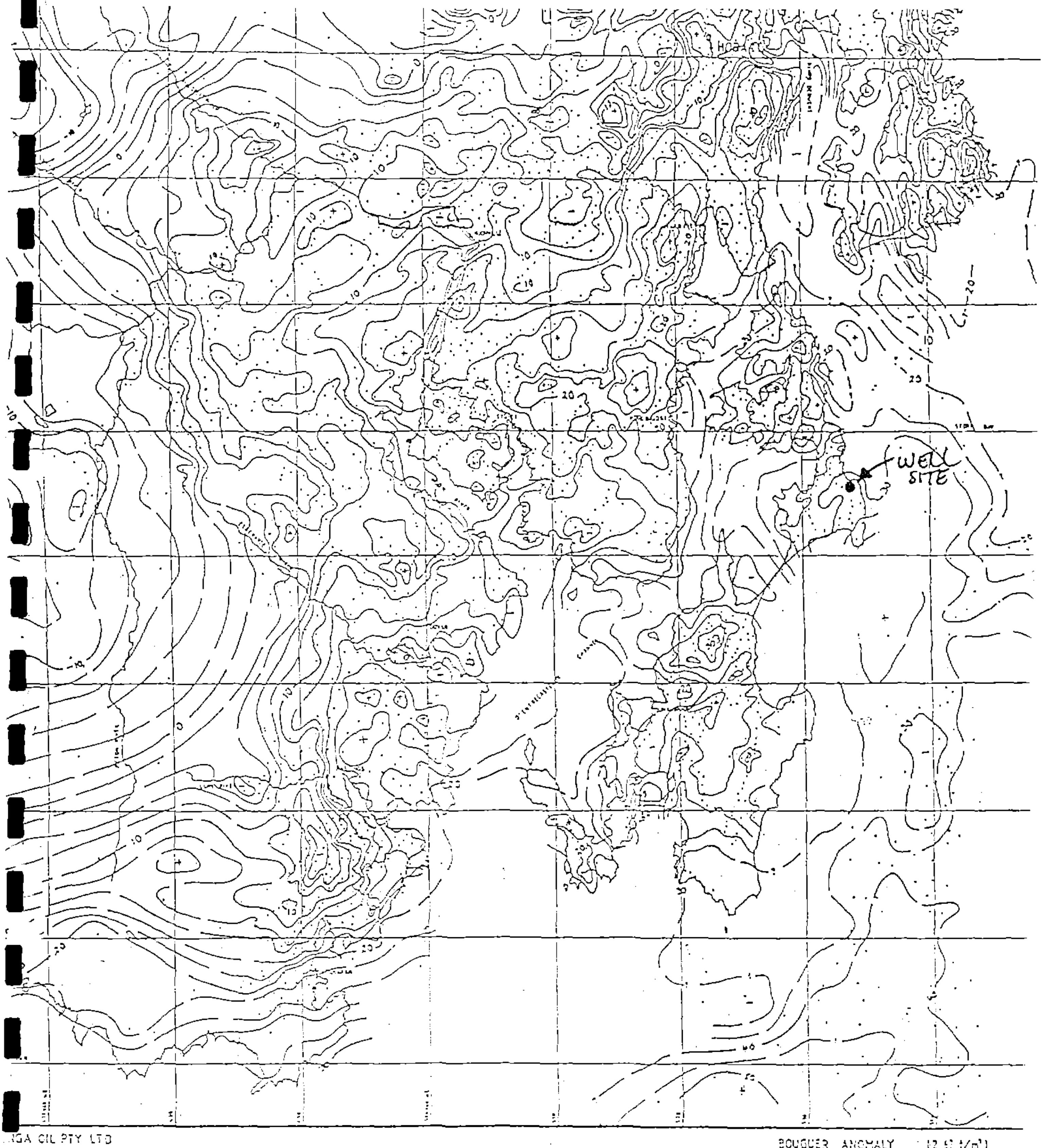
300203



CONDOR OIL INVESTMENTS NORTH BRUNY WELL
FIGURE 2

COMPILATION MAP: AEROMAGNETIC SURVEY AT 1000 M ASL

(Use transparent geographic overlay to locate positions)



GA OIL PTY LTD

PROJECT : D'ENTRECASTEAUX GRAVITY SURVEY

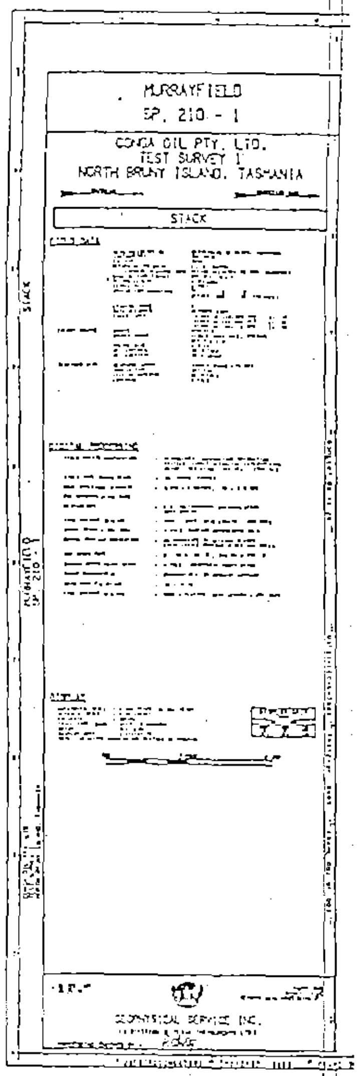
BOUGUER ANOMALY (2.67 t/m³)

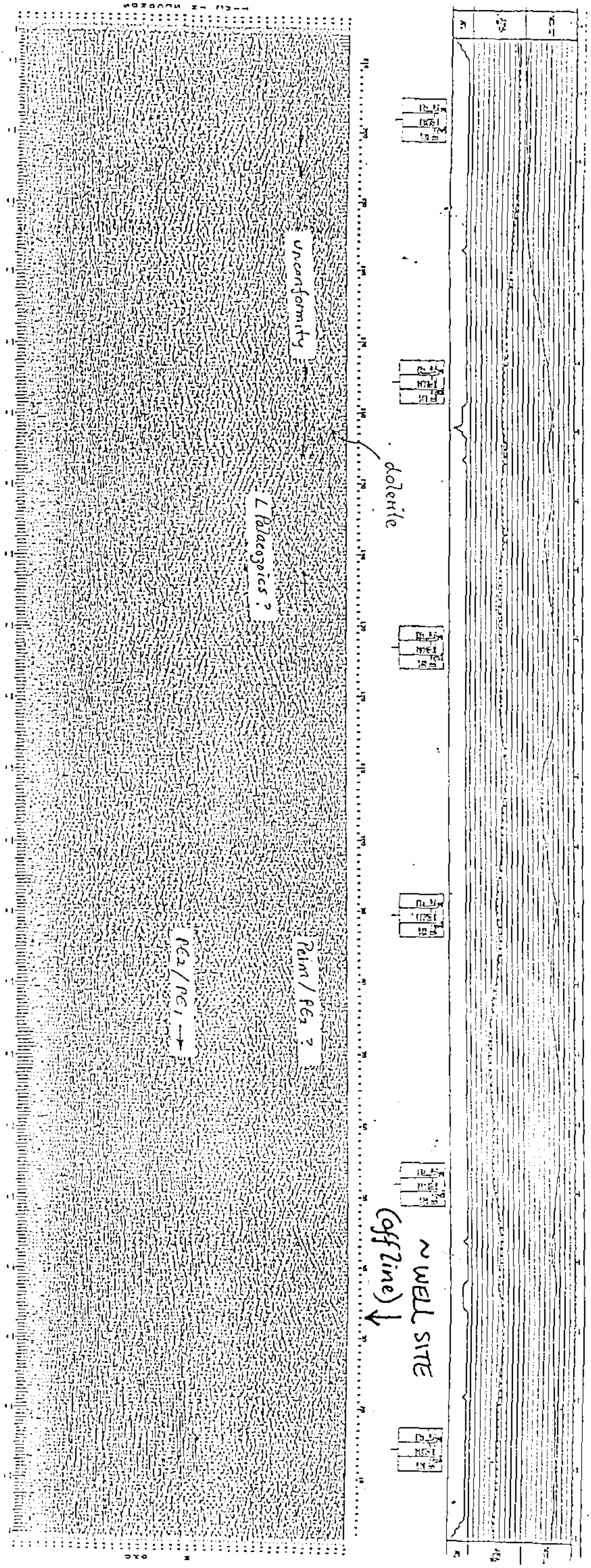
300204

GRAVITY FIELD IN SOUTH EAST TASMANIA

CONDOR OIL INVESTMENTS
FIGURE 3

300205

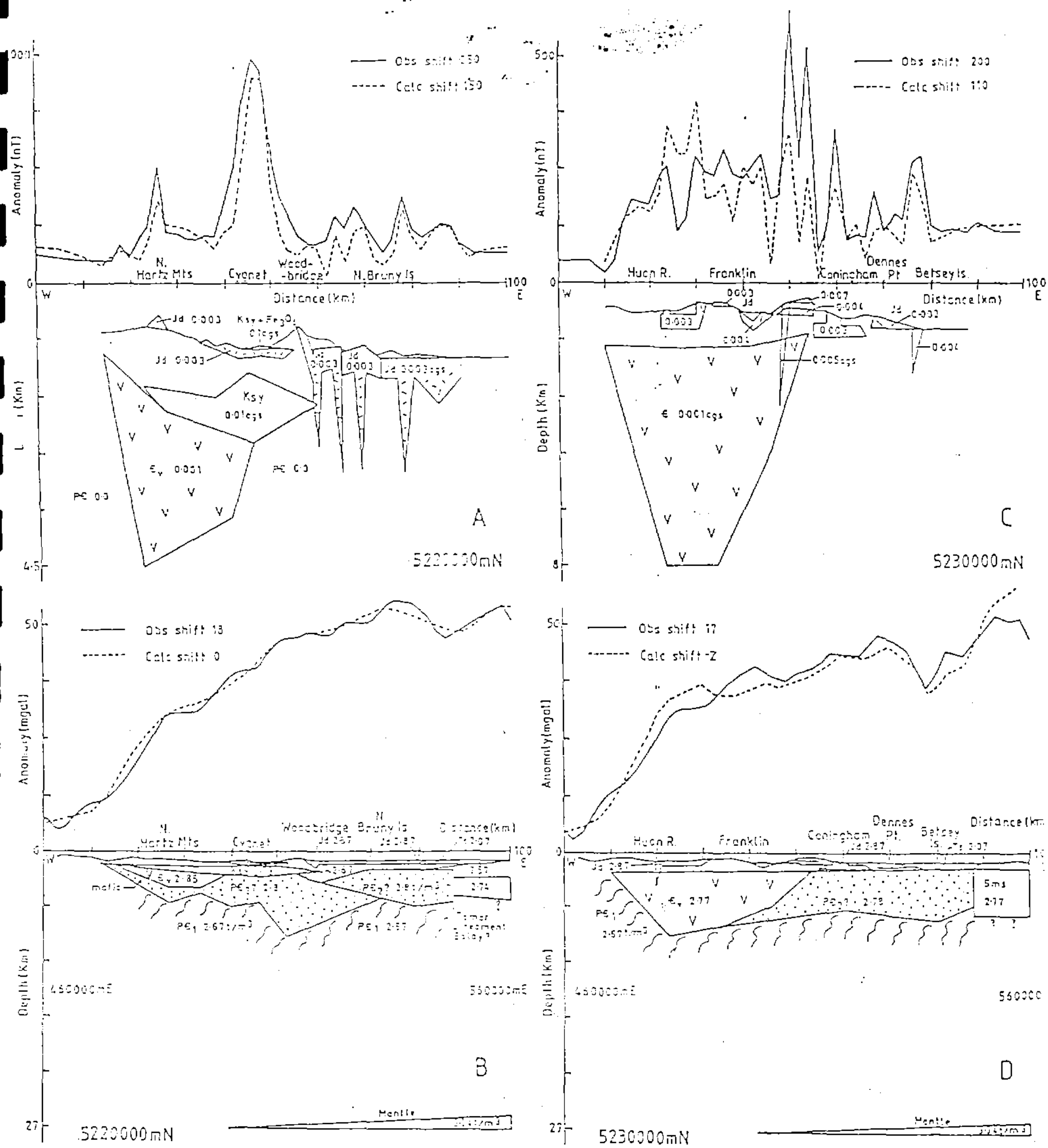




MURRAYFIELD TRAVERSE
NORTH BRUNY ISLAND

CONDOR OIL INVESTMENTS
NORTH BRUNY WELL

FIGURE 4

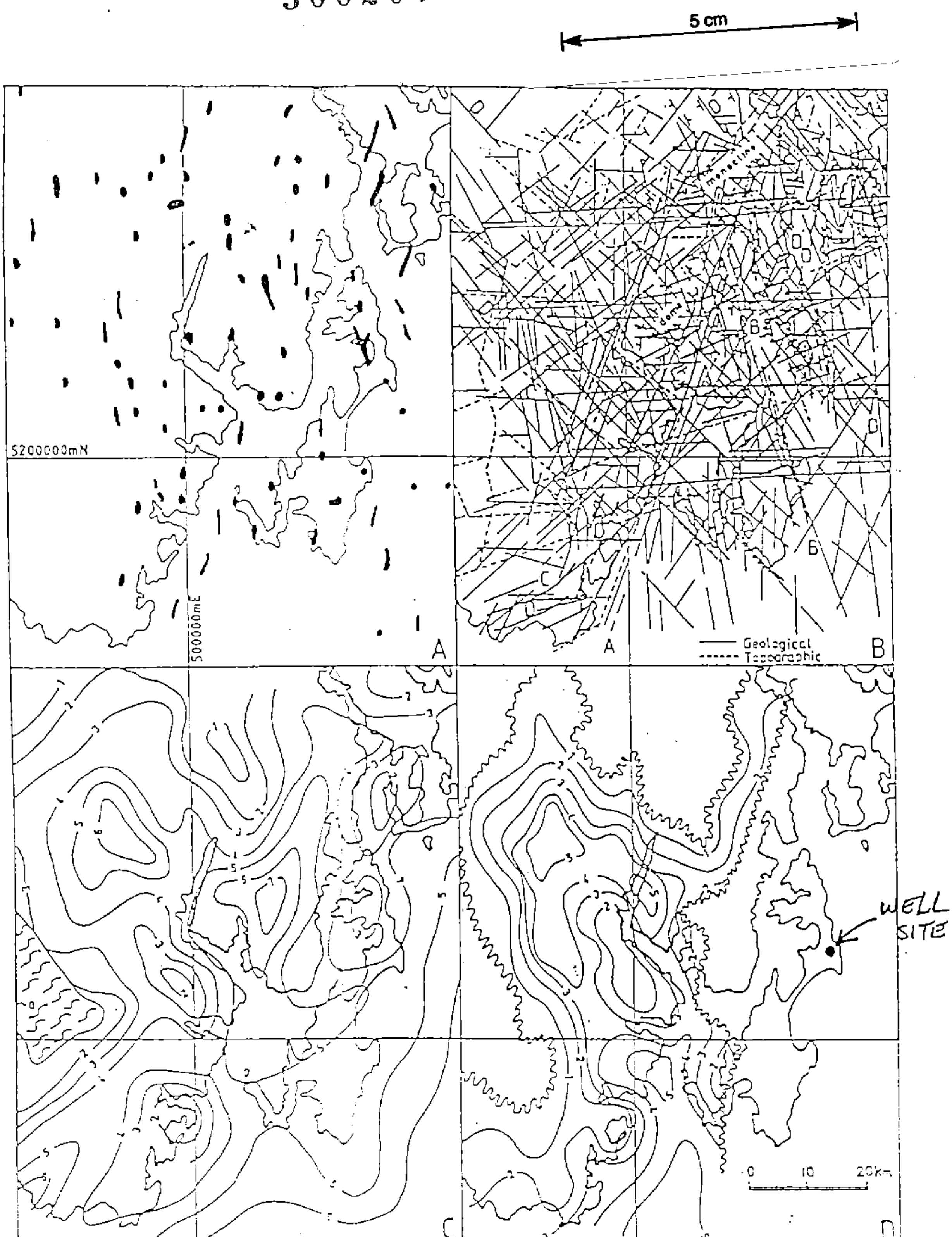


CONDOR OIL INVESTMENTS
INTERPRETED SECTIONS ACROSS BRUNY ISLAND

EXAMPLES OF INTERPRETATION MODELS AND CHARACTER OF MAGNETIC AND GRAVITY FIELDS IN SOUTH EAST TASHANIA

FIGURE 5

300207



CONDOR OIL INVESTMENTS

SUMMARY OF STRUCTURAL INFORMATION DEDUCED FROM GRAVITY AND MAGNETIC DATA IN SOUTH EAST TASMANIA. See also Figures 5B, 5D, 5E.

A: Location and orientation of Jurassic dolerite feeders. The pattern is non random and is related to older flexures.

B: Trend summary diagram, all data. Labelled structures exemplify major axes rejuvenated.

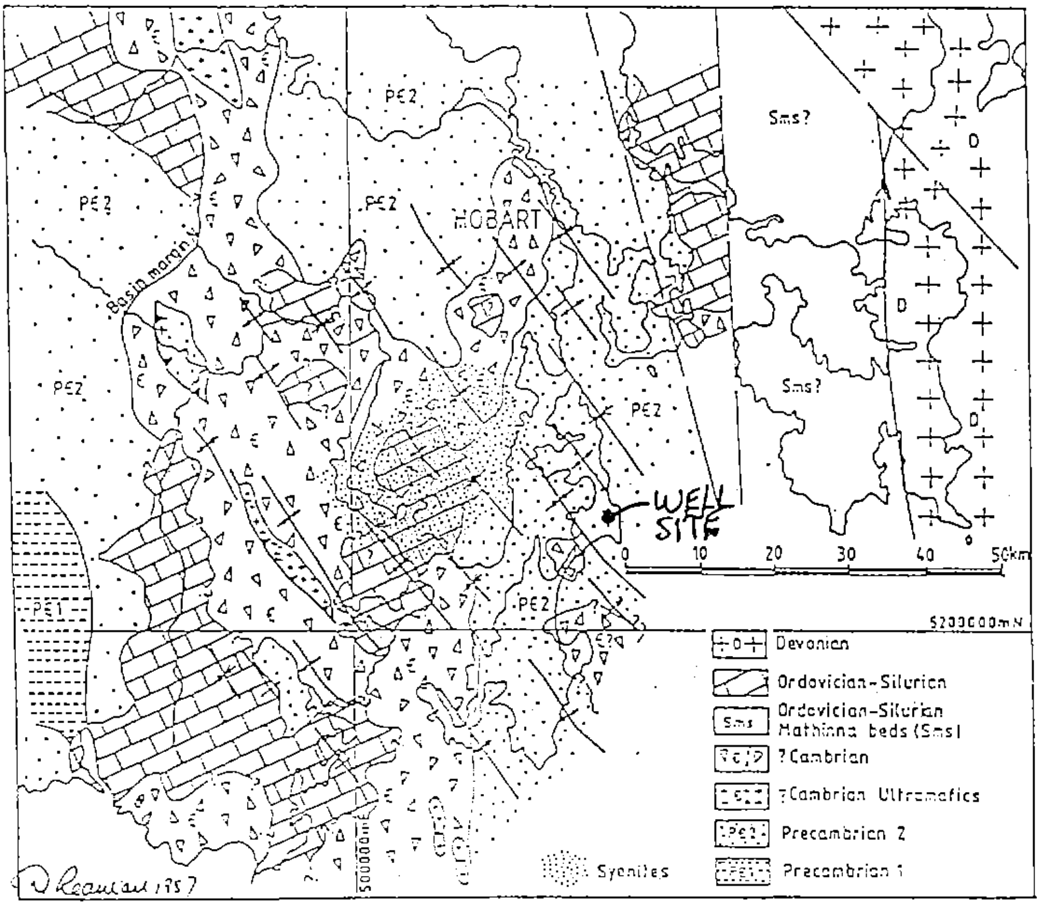
C: Contours in km below sea level of depth to crystalline basement.

D: Contours in km below sea level of base of Cambrian (?) units - incl. volcanics. Gap between C and D represents a variable thickness of Late Precambrian dolomitic sequences.

FIGURE 6

300208

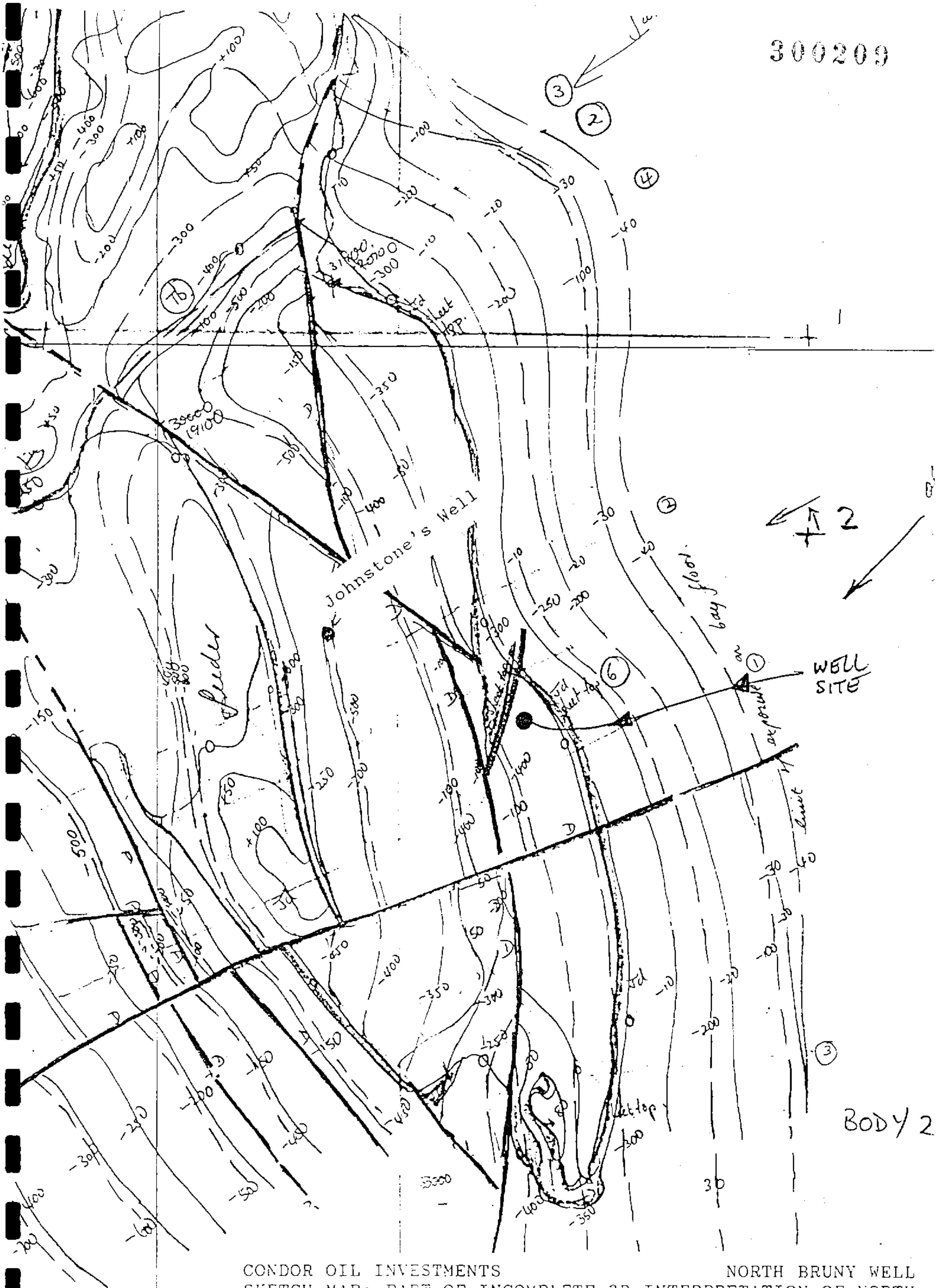
5 cm



NATURE OF GEOLOGY INFERRED BENEATH PERMIAN UNCONFORMITY IN SOUTHERN TASMANIA
(based on initial geophysical interpretations. Provisional)
Note that distribution of Ordovician-Silurian rocks is not yet well defined and will be the subject of second order refined analysis. The indicated fold systems are likewise sketchy at this stage.
Compare this plan with sections and basin structure contours in

CONDOR OIL INVESTMENTS NORTH BRUNY WELL

FIGURE 7

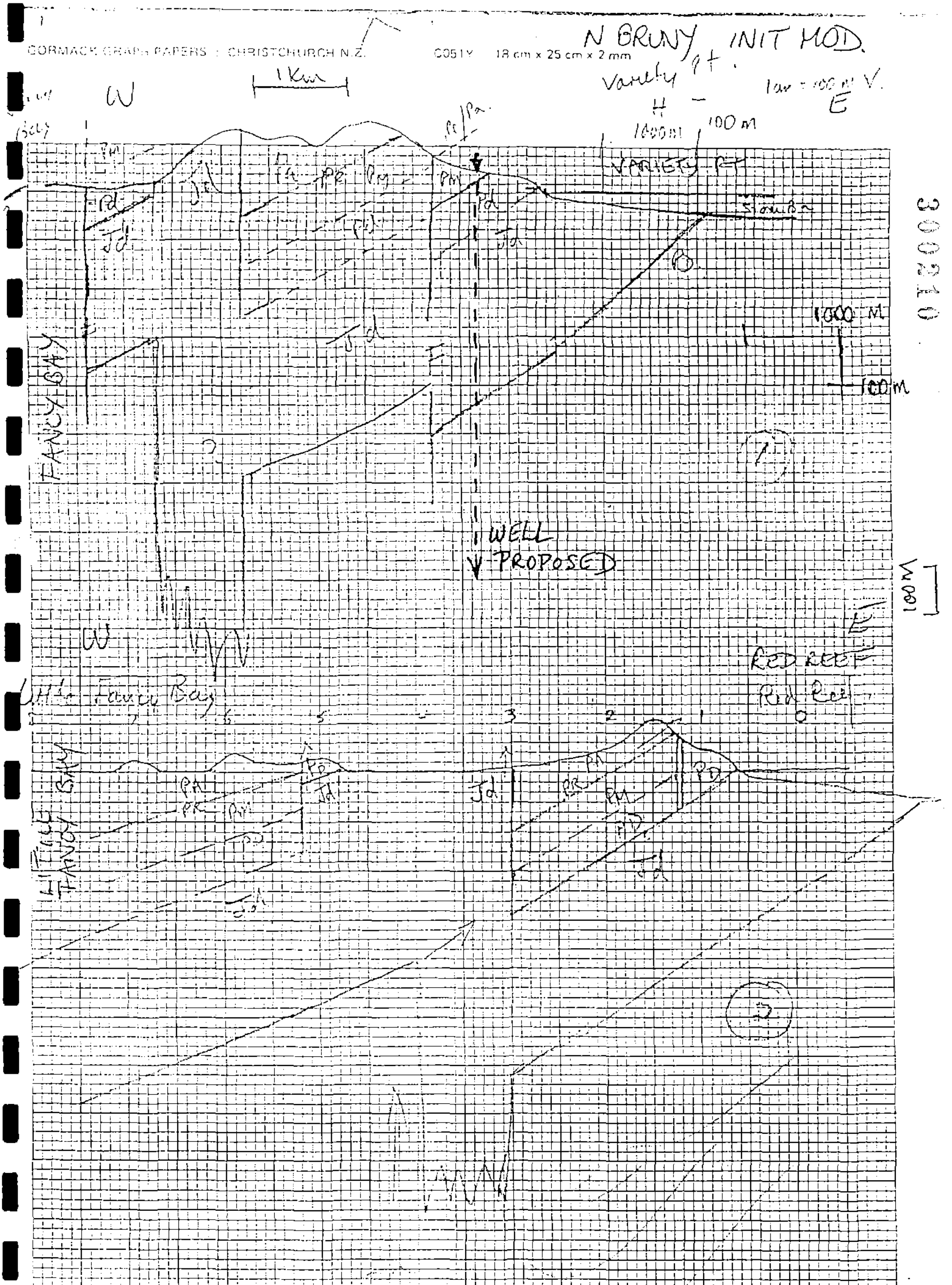


CONDOR OIL INVESTMENTS NORTH BRUNY WELL

SKETCH MAP: PART OF INCOMPLETE 3D INTERPRETATION OF NORTH BRUNY REGION SHOWING LOCATION AND CONTINUITY OF DEEPER FAULTS

Analysis by Leaman Geophysics 1988

FIGURE 8



300210

CONDOR OIL INVESTMENTS NORTH BRUNY WELL
SKETCH SECTIONS: VARIETY BAY AND GREAT BAY REGION
Upper section through well site.
Draft section by Leaman Geophysics 1988

FIGURE 9

WEDNESDAY

300211

CASING TO 2 METRES

120M ABOVE SEA LEVEL - 70M ABOVE SHITTIM 1.

GILGAL 1

METRES	GEOLOGY
0 - .5	SOIL
.5 - 1.7	SANDSTONE
1.7 - 7.5	MUDSTONE
7.5 - 9	SANDSTONE & MUDSTONE
9 - 12m	SANDSTONE & MUDSTONE
12 - 15 m	SANDSTONE & MUDSTONE
18 - 24m	MUDSTONE (GREY)
24 - 27m	MUDSTONE
27 - 30m	"
30 - 36m	"
33 36	"
36 -	RED BAKED MUDSTONE
36 - 39	PASCAL YELLOW, TAN, RED MUDSTONE
39 - 42	"
42 - 45	CLAY
45 - 48	"

SAMPLE 8.40 AM

G 1	0 - 9m
G 2	9 - 15m
G 3	15 - 27m 10.10AM
G 4	27 - 36m 10.45 AM
G 5	36 - 45m 11.40 [illegible]

SHITTIM 1.

0 - .3m	SOIL		CASING TO 2.5 METRES
.3 - 1.2m	CLAY		
1.2 - 6m	BEDROCK	SANDSTONE	12.20 p.m. MOND.
6 - 9m	BEDROCK	SANDSTONE - COARSE GRAVEL	
9m - 12m	"		
12 - 15m	"		14m CHANGE (FAULT) THEN GREEN STAIN
15 - 18m	"	LIMESTONE	15.2m CAP
18 - 21m	"	"	
21 - 24m	"	SHALE/MUDSTONE	CHANGE 2.25 PM
24 - 27m	"		
27 - 30m	"		
30 - 33m	"	SILICIFIED	3.10 PM
48m STOP		CALCIFIED	PYRITE 5 - 20%
48m RESTART	WATER WARM/ SALINE	LIMESTONE	
58m		QUARTZITE BANDS	NO PYRITE
60m		WITH LIMESTONE	TUE 10.35 AM
64m	GAS	WITH PYRITE	
73m		REPLACEMENT & GREEN STAINING	1.35PM
81m	SWEET GAS INFLOW		

STOPPED HOLE 4.30 PM

GILGAL 1

- DRY HOLE FROM SURFACE TO 45 METRES
- 45 M TO 51 M MOIST WITH STICKY CLAY WHICH WAS IMMISSIBLE WITH WATER
- GAS IN FLOW AT PRESSURE (SOUND OF WHISTLING NOISE) AFTER REMOVAL OF DRILL STRING, CLOUDING AS IT MOVED UP THE HOLE, MILD AROMA OF GAS WHEN CAP OF HOLE REMOVED AFTER 30 SECONDS.
- FULL COLUMN OF WATER PUMPED INTO THE HOLE TO FULL, GAS BOILING THROUGH THE WATER UP UNTIL 2 METRES FROM THE TOP THEN BUBBLING AND EFFERVESCENT AT TOP 51 METRES OF WATER HEAD.
- CASING PUT IN 17 HOURS AFTER DRILLING
- GREASE ON JOINTS OF RODS
- MACHINERY OIL FOR HAMMER LUBRICATION
- NO DIESEL SPILT ON THE SITE
- NO DIESEL WAS PUT DOWN THE HOLE.

M.R. Bendall

ANNULAR

SHITTIM 1

- GAS AT 64 M to 81 M
- 1 FT VUGS FROM 64 M ONWARDS
- POROUS S$CTIONS WERE INTERSECTED
- 7000 GAL PER HOUR WATER
- BRINE MORE THAN 2,000 PPM
- TAR IN JOINTS (BLACK, SOFT, SHINY)
- SMELL OF GAS VERY STRONG (UNPLEASANT SMELL)
- HOT WATER AT 64 METRES (ABOUT 40'C BASED ON BODY TEMP.)
- GREASE ON JOINTS OF RODS
- MACHINERY OIL FOR HAMMER LUBRICATION
- NO DIESEL SPILT ON THE SITE
- NO DIESEL WAS PUT DOWN THE HOLE
- 2 DAYS TO DRILL THE HOLE INCLUDING CASING AT 150 MM TO 2.5 METRES
- 5½ " HOLE FROM 5 M TO 81 M DRILLED BY AN AIR HAMMER OPERATING AT 175 PSI

M. R. Bendall

Pectil Engineering Services
Oil & Gas Drilling Engineering Consultants
26 Colin Street West Perth Western Australia 6005 Tel (09) 481 3322 Fax (09) 481 3330

Mr Malcolm Bendall
Condor Oil Investments Pty Ltd
84 Wells Pde Blackmans Bay
Tasmania 7052

DATED 14/11/94

Dear Sir

the enclosed

Preliminary Well Plan
Slimhole Stratigraphic Drilling Program
for Condor Oil Investments Pty Ltd

may assist your company preparing the two hole drilling program we discussed recently. The Well Plan still requires a general stratigraphy description and data search before a schedule, casing plan and mud program can be presented. Costing for each well may then be established. Should your geologist have this information for the area in which you are planning these wells it would assist this process considerably.

In preparing to drill these wells it will be necessary to develop a Well Plan inside an "Operating Procedures and Emergency Response Manual" for the Department of Mineral Resources in your state.

Pectil Engineering Services has developed a Slimhole Oil & Gas Drilling Manual which could assist your company with this work.

I should be pleased if you were to consider using my services in the role of drilling engineer and drilling supervisor for your program since I have considerable experience planning and drilling both conventional and slimhole oil and gas exploration and development wells.

Thank you for your consideration in this matter and I look forward to hearing from you in due course.

Yours faithfully
Pectil Engineering Services

Edward C McNally BSc, CPEng
Manager

Pectil Engineering Services
Oil & Gas Drilling Engineering Consultants
26 Colin Street West Perth Western Australia 6005 Tel (09) 481 3322 Fax (09) 481 3330

Preliminary Well Plan
Slimhole Stratigraphic Drilling Program
for Condor Oil Investments Pty Ltd

Well Name		**Shire**	
Location		**Coordinates**	
State	**Tasmania**	**Elevation**	
		Datum	**Footclamps**
		Rig Make	**UDR 1500**
Anticipated Spud Date	**September 1994**	**Projected Depth**	**1,500 m**

Operator	Sydney Oil Company Drilling & Exploration Trust ACN 010 361 350 C/- Howath & Howath Australia Place, 15 William Street Perth WA 6000 Tel (09) 322 1142, Fax (09) 322 1143
Company Representative	Mr Malcolm Bendall
Drilling Contractor	Diamond Drilling Pty Ltd PO Box 105 Zeehan Tasmania 7469 Tel (004) 71 6339, Fax (004) 71 6585
Drilling Engineering	Pectil Engineering Services PO Box 913 West Perth WA 6872 Tel (09) 481 3322, Fax (09) 481 3330
Drilling Supervisor	Edward C. McNally
Geological Supervisor	
Drill Fluid Engineering	Pectil Engineering Services
Geophysical Logging	BPB Australia
Mud Logging	Exlog
Casing	Western Deep Hole Drilling
Cementing	Local Contract
Surveying	Ace Drilling Pty Ltd
Blowout Preventer Stack	Pectil Engineering Services
Production Testing	Haliburton

Pectil Engineering Services
Oil & Gas Drilling Engineering Consultants
26 Colin Street West Perth Western Australia 6005 Tel (09) 481 3322 Fax (09) 481 3330

Preliminary Well Plan
Slimhole Stratigraphic Drilling Program
for Condor Oil Investments Pty Ltd

Well Configuration

	Hole Size	Casing Size	OD (in)	OD (mm)	ID (in)	ID (mm)	Weight (kg/m)
Conductor	6.625"	PW	5.5	139.7	4.94	125.5	23.14
Surface Hole	4.875"	HW	4.5	114.5	4.00	101.4	16.83
Intermediate	3.782"	HQ	3.5	88.9	3.063	77.8	11.45
Objective Hole	2.98	NQ	2.76	70.0			

Drilling Program

	Hole Size	Casing Size	Drilling Method	Max Depth	Mud System	Drilling Method
Conductor	6.625"	PW	A/Percussion			DHH
Surface Hole	4.875"	HW	Mud Rotary	900 m	FW Gel	Button Tricone
Intermediate	3.782"	HQ	Diamond Core	1,200 m	Brine Polymer	Impregnated
Objective Hole	2.98	NQ	Diamond Core	1,800 m	Brine Polymer	Impregnated

Anticipated Drilling Schedule

Activity	Time
Mob and unpack	
Rig up	
Establish water bore	
Drill and set PW conductor pipe	
Mud rotary drilling to surface HW casing point.	
Run and cement surface HW casing	
Install and test BOP's	
Diamond HQ core drill to intermediate casing point.	
Run E logs suite	
Run and cement intermediate HQ casing	
Install and test BOP's	
Diamond NQ core drill to TD	
Run E logs suite	
Cement abandonment plugs	
Rig down	
Packup and Demob	

Rig Hourly Rate **$/hour**

Drilling Rates

Pre-Collar
0 - 100 m
100 -200 m
200 -300 m

4 7/8" Mud Rotary Drilling
0 - 600 m
600 - 800 m
800 - 900 m
600 - 800 m

HQ Coring
0 - 600 m
600 - 800 m
800 - 1000 m
1000 - 1200 m

NQ Coring
0 - 600 m
600 - 800 m
800 - 1200 m
1200 - 1600 m
1600 - 1800 m

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Preliminary Well Plan
Slimhole Stratigraphic Drilling Program
for Condor Oil Investments Pty Ltd

Diamond Drilling UDR 1500 Drill Rig Description

Drill	Universal 1500 all Hydraulic Top Drive
Mast	16 m length with 12 m rod pull capacity
Power	172 kW GM 6-71N Diesel, 2100 rpm
Rotation Head	Top drive direct couple. High-Low manual gear range 5-380 rpm low range, 380-1500 high range Stepless speed range
Rotation Head Torque	Max 6,800 Nm low range, 360 Nm @ 1,500 rpm high range Fully automatic torque speed control running diamond bits at maximum
General Features	50 mm (2") ID floating hollow spindle, jet lubricated gears and bearings possible rpm using maximum available horsepower Water to oil heat exchanger.
Head Traverse	Hydraulic cylinder over chain with 7.32 m of traverse Max traverse speed 24 m/min up and 18 m/min down Hydraulic head racks back in top mast
Pull Down	7,000 kg
Pull Up	15,000 kg
Water Pump	2 * FMC Bean triplex pumps Rated 140 LPM (36 USG/min), 7,000 kPa (700 psi)
Rod Breakout	Hydraulic Rigid Stillsons 9,500 Nm makeup torque, 12,000 Nm breakout torque
Rod Clamps	44.5 mm (1.75") to 168.3 mm (6.625") in rod clamps with 8.75" clamp opening Hydraulic, self energizing with hammer wrenches and bit baskets
Wireline Winch	2,000 m of 10 mm (3/8") wire rope. 1,800 kg full drum pull at 260 m/min
Hydraulics	Axial and radial piston pumps designed with 3 independent open loop circuits (Main - Water - Cylinders)

Depth Rating

Drilling Method	Hole Size	Rod Size	Rated Depth	Diamond Core
Air DHH	127 mm	73 mm	816 m	
Mud rotary	165 mm	89 mm	663 m	
Diamond Core	122.6 mm	117.5 mm	900 m	PQ
	96.0 mm	89 mm	1,200 m	HQ
	75.3 mm	70 mm	1,800 m	NQ
	60.0 mm	56 mm	2,300 m	BQ

Drill Dimensions

Weight	Length	Width	Height
19,500 kg	16 m	2.5 m	3.6 m

Bare drill on hydraulic jackup tray

Pectil Engineering Services
Oil & Gas Drilling Engineering Consultants
26 Colin Street West Perth Western Australia 6005 Tel (09) 481 3322 Fax (09) 481 3330

Preliminary Well Plan
Slimhole Stratigraphic Drilling Program
for Condor Oil Investments Pty Ltd

Slimhole Oil & Gas Drill hole Cost Summary

Description	***Supplier***	**Cost**
Location access, site survey and preparation		
Mobilisation, unpack and establishment		
Demob, site restoration		
Water trucking		
Water bore and materials		
Well site drilling supervisor	E. C. McNally	
Rig Hire	Diamond Drilling Pty Ltd	
Wages and on costs		
Camp hire and catering		
Fuel & lubricants		
Mud chemicals and engineering	Pectil Engineering & MI	
Communications		
Miscellaneous intangibles		
Cement and chemicals		
Cementing plant rental		
PW, HW & HQ Casing and casing handling		
Casing tooling		
Lynes DST tool rental		
Core equipment	Diamond Drilling Pty Ltd	
Core handling and core analysis		
Portable cellar	Pectil Engineering	
Blowout preventer equipment rental	Pectil Engineering	
Kill and test pump	Pectil Engineering	
HW well flange	Pectil Engineering	
Downhole drill and casing tooling		
Ancillary surface mud handling equipment rental		
Ancillary mud surface equipment		
Mud logging	Exlog Gas Detector	
Geophysical wireline logging	BPB Australia	
Materials transport		
Personnel transport		
Well insurance		
Well overheads (3%)		
Office and administration		

Diamond Core Drilling

Table D3: Physical Properties of Diamond Drill Rods

Rod Size	Nominal OD * ID (mm)	Wall Thickness (mm)	TPI	Coupling Dimension (mm)	Mass kg/m	Rod Capacity litre /10 m	Rod Plug Displacement litre / 10 m
Original Diamond Core Drill Rods							
E	33.3 * 21.4	6.0		11.1	4.17	3.6	8.71
A	41.3 * 28.6	6.4		14.3	5.61	6.4	
B	48.4 * 35.7	6.4		15.9	6.82	10.0	
N	60.3 * 50.8	4.8		25.4	7.28	20.3	
DCDMA 'W' Series Core Drill Rods							
RW	27.8 * 18.3	4.8	4	10.3	2.82	2.6	6.07
EW	35.0 * 25.4	4.8	3	12.7	3.74	5.1	9.62
AW	43.8 * 34.1	4.8	3	15.9	4.91	9.1	15.07
BW	54.1 * 44.5	4.8	3	19.0	6.23	15.6	23.00
NW	66.8 * 57.2	4.8	3	34.9	8.03	25.7	35.05
HW	89.1 * 77.8	5.7	3	60.3	12.66	47.5	62.35
Longyear Wireline Core Drill Rods							
EQ	34.9 * 26.5	4.2	4	26.5	3.20	5.5	9.6
AQ	44.5 * 34.9	4.8	4	34.9	4.63	9.6	15.6
BQ	55.6 * 46.0	4.8	3	46.0	5.97	16.6	24.3
BCQ-Composite	55.6 * 47.6	4.0	3	46.0	5.15		
NQ	70.0 * 60.3	4.9	3	60.3	7.58	28.6	38.5
NCQ-Composite	69.9 * 61.9	4.0	3	60.3	6.56		
HQ	88.9 * 77.8	5.6	3	77.8	11.45	47.5	62.1
HCQ-Composite	88.9 * 80.9	4.0	3	77.8	8.52		
PQ	114.3 * 103.2	5.6	3	103.2	15.26	83.6	102.6
Longyear Composite Heavy Duty Wireline Core Drill Rods							
CHD 76	69.9 * 60.3	4.8	2.5	55.0	9.2 / 8.5	28.6	38.5
CHD 101			2.5				
CHD 134			2.5				

CQ rods have 'Wedge Lok' tapered thread design

Table D4: Longyear W Series Flush Joint Casing to DCDMA CDDA & BSI Standards

Rod Size	Nominal OD * ID (mm)	Wall Thickness (mm)	Coupling Dimension (mm)	Mass kg/m	Rod Capacity litre /10 m	Rod Plug Displacement litre / 10 m
EW	46.0 * 38.1	3.95		4.16		
AW	57.1 * 48.4	4.35		5.64		
BW	73.0 * 60.3	6.35		10.43		
NW	88.9 * 76.2	6.35		12.80		
HW	114.3 * 101.6	6.35		16.83		

Joints with 4 thread per inch coupling supplied in 2 (609.6 mm), 5 (1524 mm) and 10 (3048 mm) foot.

COPY

15th November, 1994.

Pectil Engineering Services,
26 Colin Street,
WEST PERTH W.A. 6005

Dear Sir,

RE: BLOWOUT PREVENTOR PURCHASE

Thank you for your letter of the 14th November, 1994.

We wish to advise that following negotiations with the Mines Department, we will no longer need a Blowout Preventor. We would therefore request that you stop preparations for forwarding same.

Would you please supply an account for your work to date which you indicated would be approximately $2,000.

Yours faithfully,

M.R. BENDALL
MANAGING DIRECTOR

Facsimile Cover Sheet

To:	Malcolm Bendall
Company:	Condor Oil Investments
Phone:	002 235 886
Fax:	002 292 153
From:	Edward McNally
Company:	Pectil Engineering
Phone:	(619) 481 3322
Fax:	(619) 481 3330
Date:	29/11/94
Pages including this cover page:	8

Comments:

HELLO MALCOLM

THE FOLLOWING ARE NOTES I USED TO PREPARE THE 800M DRILLING PROGRAM AT SANDFIRE LAST YEAR. INCLUDED ARE PICTURES OF THE BOP AND ANCILLARY PLANT USED FOR WELL CONTROL.

I SHALL BE INSPECTING AND COSTING THE EQUIPMENT THIS WEEK AND WILL FORWARD YOU THE COST FOB

kind regards

E. McNally

TED

$250 per

$8,000

$5000 [illegible]

DRILLING OPERATIONS SD - 1

WELL CONTROL

A component diagram and test schedule are included in the following pages. (See Drill Hole BOP diagram).

Practices to shut in the drill hole and control abnormal pressure

1. Drilling
2. Tripping the rods in and out of the hole or
3. With the rods at surface and
4. Pulling the inner core barrel

are described in Slimhole Drilling Operations Manual - E. McNally 1991. A copy of the manual was on the location.

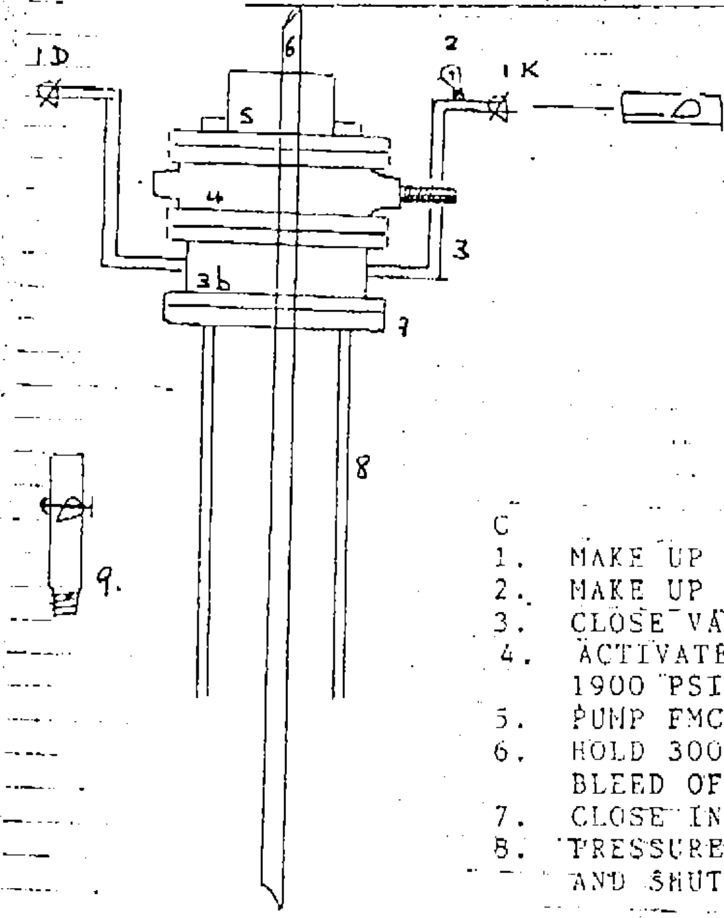
Practices adopted to control abnormal pressure developments (artesian flow) were prepared using the ODCAA - University of Qld. DMME Manual killsheet.

Pressure tests to establish the integrity of HW and HQ casing strings were carried out after cementing and bumping the cement wiper plug. Both strings tested to 800 psi for one minute.

No pressure integrity testing of formation below the HQ/HW casing shoe were conducted to establish leak off The low integrity of sandstones in the Wallal and Grant had been well demonstrated while drilling and testing would not have assisted the shoe.

DRILLING OPERATIONS SD-1

BOP FUNCTION TEST SCHEDULE C



C
1. MAKE UP INSIDE BOP ON HQ
2. MAKE UP POWER HEAD
3. CLOSE VALVES
4. ACTIVATE ANNULAR PREVENTER 1900 PSI FOR 3 MINUTES
5. PUMP FMC-36 RIG PUMP TO 300 PSI
6. HOLD 300PSI FOR 3 MINUTES THEN BLEED OFF
7. CLOSE INSIDE BOP
8. PRESSURE UP FMC-36 TO 800 PSI AND SHUT IN FOR 3 MINUTES

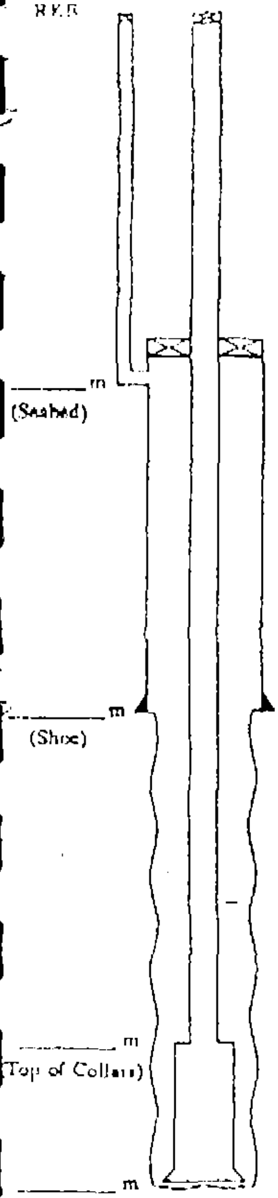
23/10/92 0630 HRS

HQ ROD INSIDE HW CASING RODS
PRESSURE TEST TO 300 PSI FOR 3 MINUTES - OK BLEED OFF
CLOSED THIS BOP AND PRESURE TESTED RIG LINES TO 800 PSI FOR 3 MINUTES. OK. BLEED OFF

KILL SHEET — SI UNITS

300225

DEPTHS RKB



WELL VOLUMES AND PRE-RECORDED DATA

Annular Capacity (m³/m) = $\frac{(D^2 - d^2)}{1273240}$ where D = mm ID of hole or casing, d = mm OD of pipe or collars.

Section	D	d	Capacity	× Length	= Volume

Original Mud Density (kg/m³) = ______

Measured Depth (m) = ______

Pump #1 Output (m³/stk) = ______

Pump #2 Output (m³/stk) = ______

* BOP Stack/Wellhead Rating (kPa) = ______

* Casing Burst Rating (API) (kPa) = ______

* Formation Rating (LOP/PIT) (kPa) = ______

Drill String Volume (m³) = ______

Full Annulus Volume (m³) = ______

O H Ann Vol (below Shoe) (m³) = ______

#1 Slow Pump ______ kPa at ______ SPM

#2 Slow Pump ______ kPa at ______ SPM

PUMP STROKES DATA

Drill String Strokes = Drill String Vol ______ m³ ÷ Pump Output ______ m³/stk = ______ stks Ⓐ

Full Annulus Strokes = Full Annulus Vol ______ m³ ÷ Pump Output ______ m³/stk = ______ stks Ⓑ

Below Shoe Strokes = Vol below Shoe ______ m³ ÷ Pump Output ______ m³/stk = ______ stks Ⓒ

Total Strokes = Ⓐ ______ stks + Ⓑ ______ stks = ______ stks Ⓓ

DATA RECORDED OR CALCULATED AFTER A KICK

SIDPP = ______ kPa SICP = ______ kPa Pit Gain = ______ m³ TVD = ______ m

KILL Mud Density = $\frac{\text{SIDPP (\_\_\_\_\_\_) kPa}}{\text{TVD (\_\_\_\_\_\_) m} \times 0.00981}$ + ( ) kg/m³ Orig Mud Density = ______ kg/m³

INITIAL Pump Pressure = SIDPP ( ) kPa + Slow Pump Pressure ( ) kPa = ______ kPa Ⓔ

FINAL Pump Pressure = $\frac{\text{Slow Pump Press ( ) kPa} \times \text{Kill Mud ( ) kg/m}^3}{\text{Original Mud Density ( ) kg/m}^3}$ = ______ kPa Ⓕ

OFFSHORE SLOW PUMP DATA

SPM	Ch. Line	Riser	CLFP

BARYTES MUD WEIGHTING TABLE

Final Dens (kg/m³)	1100	1200	1300	1400	1500	1600	1700	1800	1900
kg increment	1.349	1.393	1.441	1.491	1.545	1.604	1.667	1.735	1.809

∴ Tot kg reqd = ( ) kg incr × Mud difference ( ) kg/m³ × ( ) m³

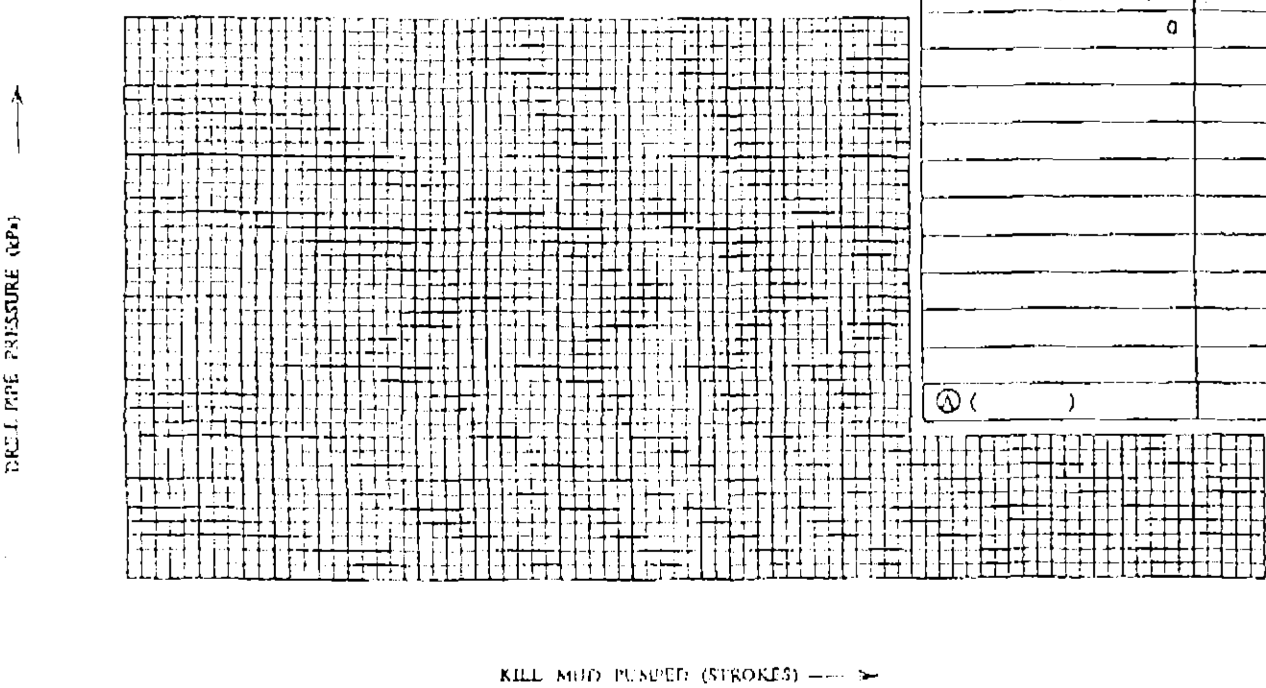
∴ Sacks required = ( ) Total kg ÷ 40 = ( ) sacks

Circulating Casing Pressure (CCP) = SICP ______ kPa − CLFP ______ kPa = ______ kPa.

MAASP ______ kPa, is the minimum of the three pre-recorded pressure ratings* and applies only up to Ⓒ (______) strokes, when the influx is inside casing/liner.

PRESSURE CHART

KILL MUD (STROKES)	DRILL PIPE PRESSURE (kPa)
0	( ) Ⓔ
Ⓐ ( )	( ) Ⓕ



Ⓒ ______ stks
Influx inside casing

Ⓓ ______ stks
Total Strokes

DRILLING OPERATIONS SD.1
Drillfluids Programme

Summary of operations drilling 3 7/8" hole from 192 to 487.5 m. (cont.)

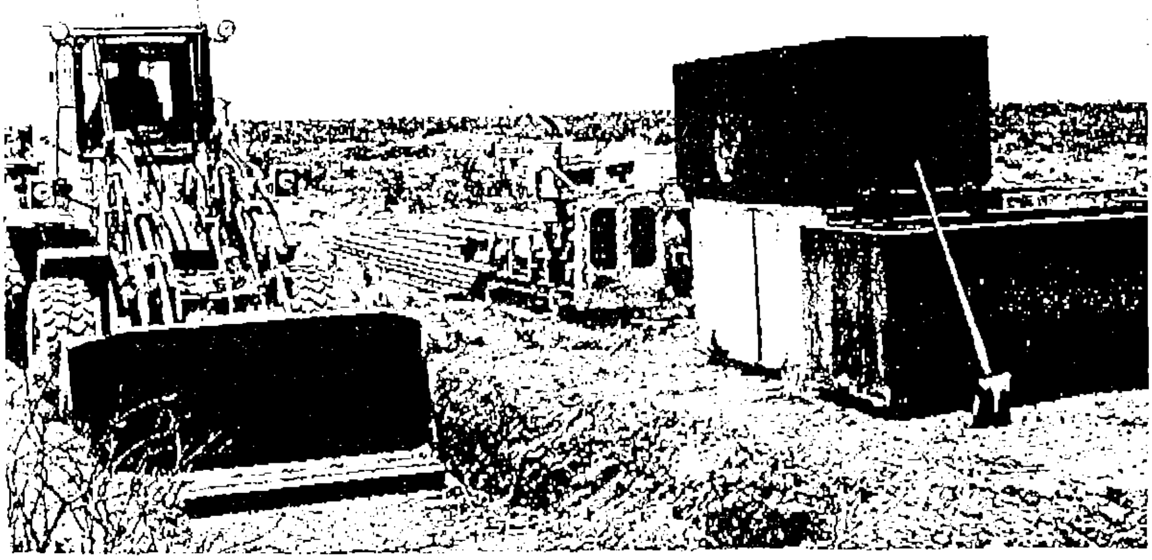
Drilling and balance could be maintained using an 8.8 to 8.9 ppg mud weight. No occurrence of overpull or torque on the rotating rods were noted in the interval while drilling. Tripping even while regulating with minimum pipe speed swabbed the hole and produced flow with a mud weight of 9.2 ppg. It frequently because necessary to displace the kill mud once inside the BW casing during the trip to control the flow. Several trips were completed out of the hole with the well still flowing and the gate valve had to be closed to contain flow while making bit changes.

Q-broxin deflocculant was made up in tank 3 while drilling mud generating clays below 456m. The tank was used to dilute highly viscosified mud returns at the flow line.

Three bits were pulled with plugged cones and locked up bearings because they had been run on bottom after plugging. Each of the bits had flattened cones. Alternating sand, slate, claystone zones made for difficult drilling with the bits and it may have been an improvement if jet or PDC bits had been selected.

Fill on bottom after tripping had to be back reamed and some time was lost stripping back to bottom at 394 and 414 m. The interval did not heave sand or shale while it was open but the bottom section increased mud solids and a thinning agent was needed to reduce viscosity.

WEIGHT & KILL
MUD TANKS



MALCOLM

BOP inside the Portable Collar.

DRILLING OPERATIONS SD-1
Casing and Cementing Programme

PROGRAMME

1. Cement plug 40 - 60 m in 8 1/2" conductor hole.

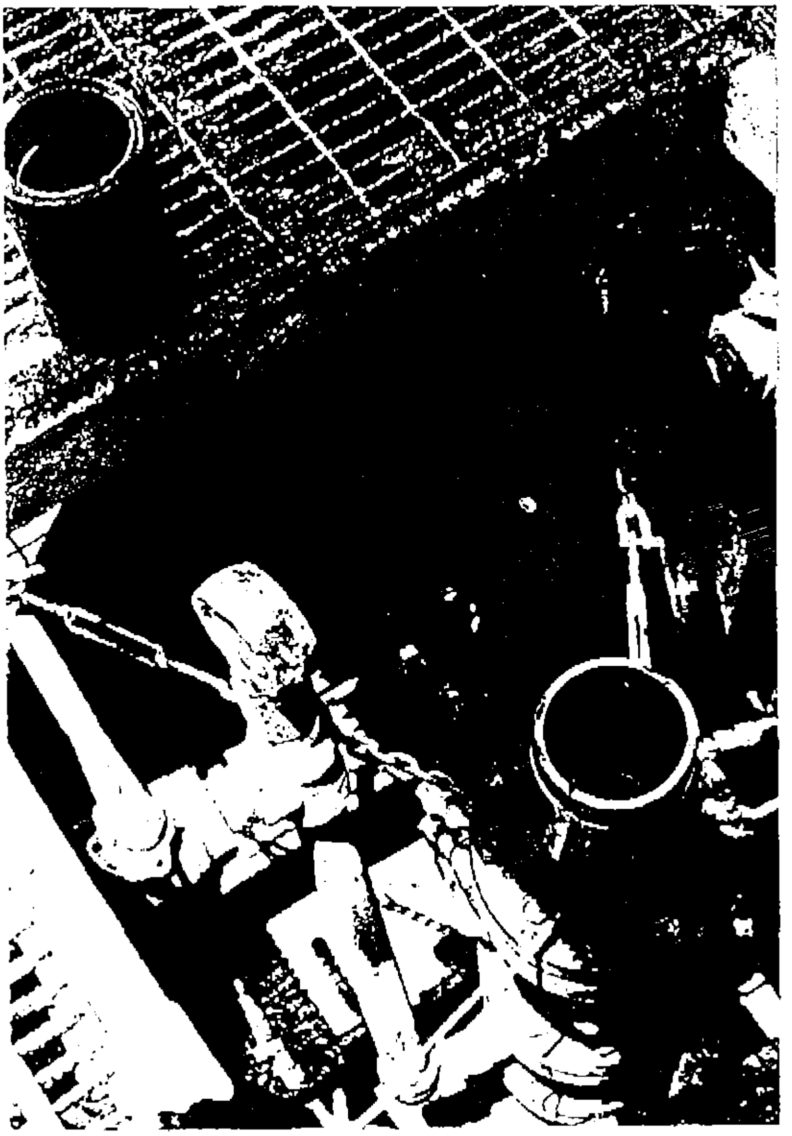
2. Cementing 6 1/2" conductor in 8 1/2" hole at 39 m.

3. Cement plug 160 to 192 m in 5 1/2" surface hole.

4. Cementing HW casing rods at 181.5 m surface.

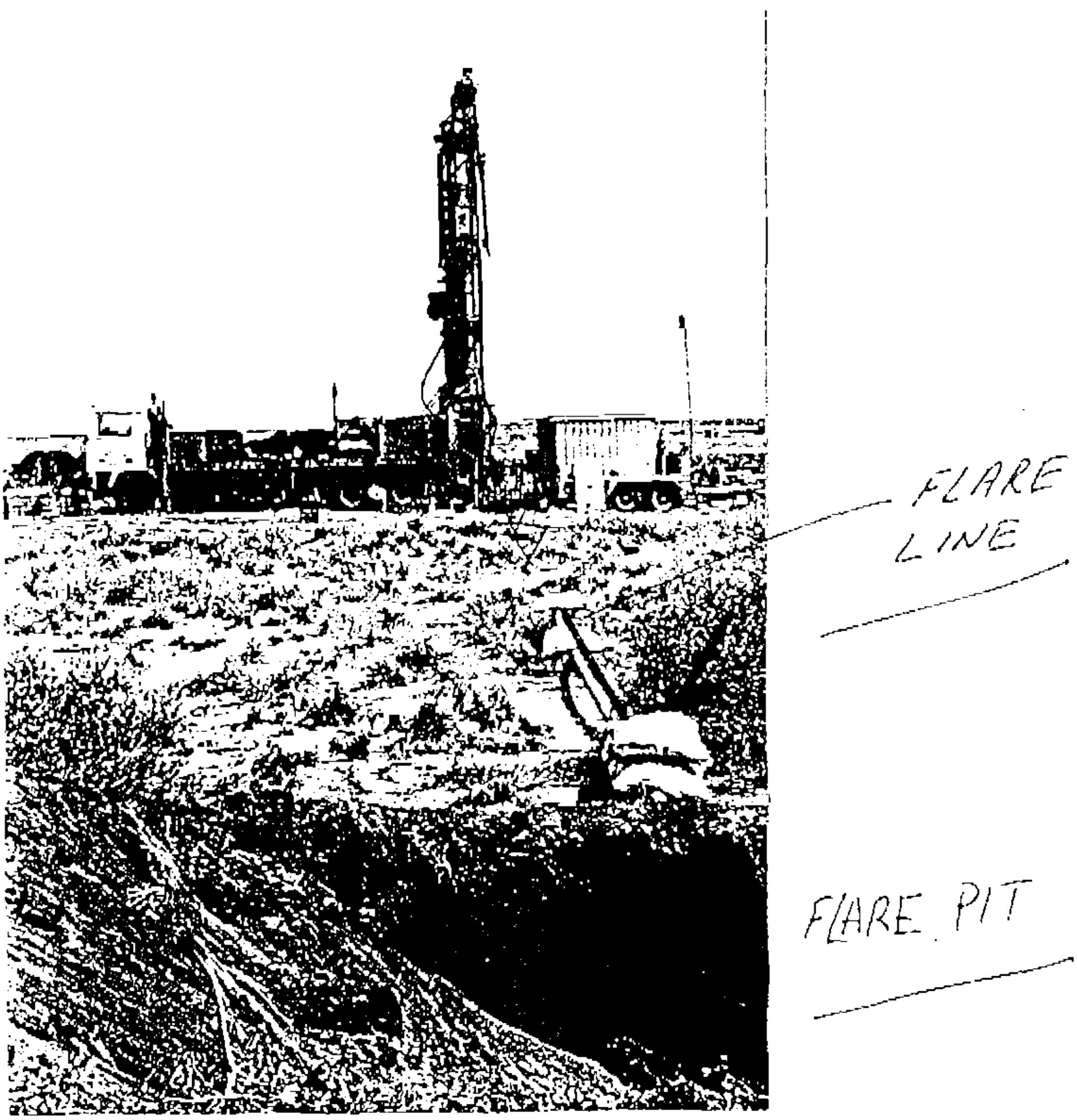
5. Cementing HQ rod string in 3 7/8" hole at 487.5 m.

6. Cement abandonment plug from 760 m to surface.



SD 1. DRILL HOLE COMPLETION REPORT

CONTENT



COPY

300230

AGSO
AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION

11 November 1994

Director, Exploration
Conga Oil PL
84 Wells Parade
Blackmans Bay TAS 7052

Dear Sir/Madam

Re: Tasmania NGMA Project ("TASGO")

The Australian Geological Survey Organisation and the Tasmanian Department of Minerals and Energy have commenced a series of multi-disciplinary studies under the National Geoscience Mapping Accord (NGMA). We are writing to you to inform you of the project and their progress and to invite you to contact the project leader or staff in the project if you want further information or wish to participate more closely in the work.

This is the first of a new series of communications to explorationists with interests in Tasmania. "TASGO" is one of the new NGMA projects and is being run jointly by AGSO and Mineral Resources Tasmania (MRT). It is designed to understand the major geological events that have influenced the distribution of Tasmania's minerals and petroleum resources.

The project was publicly launched by Tasmania's Premier, Mr Groom, on 21 August 1994. The project plan also received a mention in the August 1994 edition of AGSO's *AusGeo News* and the October/November issue of *PESA News*. It was presented to the Tasmanian Chamber of Mines at its meeting in Launceston on 24 June 1994. A brief update of activities will be given at the Chamber's next meeting in Launceston on 29 November 1994.

The initial phase of the project is dominantly data acquisition (see Attachment 1). Activities include airborne geophysics, land and marine deep reflection seismic surveying, some geochronology and a compilation of relevant geological information. This will be followed by some review work (involving collaboration with Universities and other researchers) and data processing, prior to the substantial interpretive phase.

A synthesis of relevant geological information is underway. A new 1: 500,000-scale strato-tectonic map and time-space plots of Tasmania's tectonic elements, with some relevant neighbouring parts of Gondwanaland for comparison, are being compiled using AGSO's new timescale, to provide a basis for interpreting the new data. Compilations are scheduled to become available from about late December 1994.

Airborne geophysical surveying of inshore regions of Tasmania commenced on 11 October 1994. To date 28,000 line kilometres of magnetic data have been acquired at 800m line spacing, representing nearly one third of the survey (see Attachment 2). The King Island portion will be flown at 400m line spacing and will include gamma-ray spectrometry. The data are being acquired to map the continuations of Tasmania's geological provinces and structures offshore, and to ensure that we position the deep marine seismic reflection lines to cross major structures. Data are expected to become available in the first half of 1995.

Planning for onshore deep reflection seismic surveying in February 1995 is well underway. Our budget will allow about 100 line kilometres to be shot. Tasmania's terrain is far from ideal for the seismic method. Of the traverses considered to be logistically feasible, the following have been selected along existing roads: west Dundas Trough; east Dundas Trough; Mathinna Goldfields lineament; and some experimental soundings in the Tasmania Basin, hopefully through windows in the dolerite.

Planning for the marine reflection seismic survey is also underway. An indicative cruise track is shown on Attachment 3. It is thought to cross many significant geological boundaries and structures. Precise cruise positioning will be fine-tuned when the results of aeromagnetic surveying become available later this year. The ship provides a more cost effective method for imaging the geometry of the major geological structures.

Some new zircon dating will continue in 1995. Priority will be accorded to samples that can date or put timing constraints on tectonic events, or which can improve the accuracy of the geochronological timescale at places where there is good biostratigraphic control.

If you would like to participate in any of our activities, or feel that you could assist in any way, please call us at the numbers indicated below. Further information on the project can be obtained from Tony Yeates at AGSO, telephone (06) 249 9335, or Tony Brown, State Chief Geologist MRT, telephone (002) 33 8365. Specific information on the seismic surveying can be provided by Barry Drummond, telephone (06) 249 9381 or Tim Barton, telephone (06) 249 9625.

With best wishes

Dr Tom S Loutit
Co-Chief,
Minerals Petroleum and
Sedimentary Resources Division,
AGSO

Telephone: (06) 249 9674

Mr Mike Ayre
Director of Mines
Mineral Resources Tasmania

Telephone: (002) 33 8333

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ATTACHMENT 1

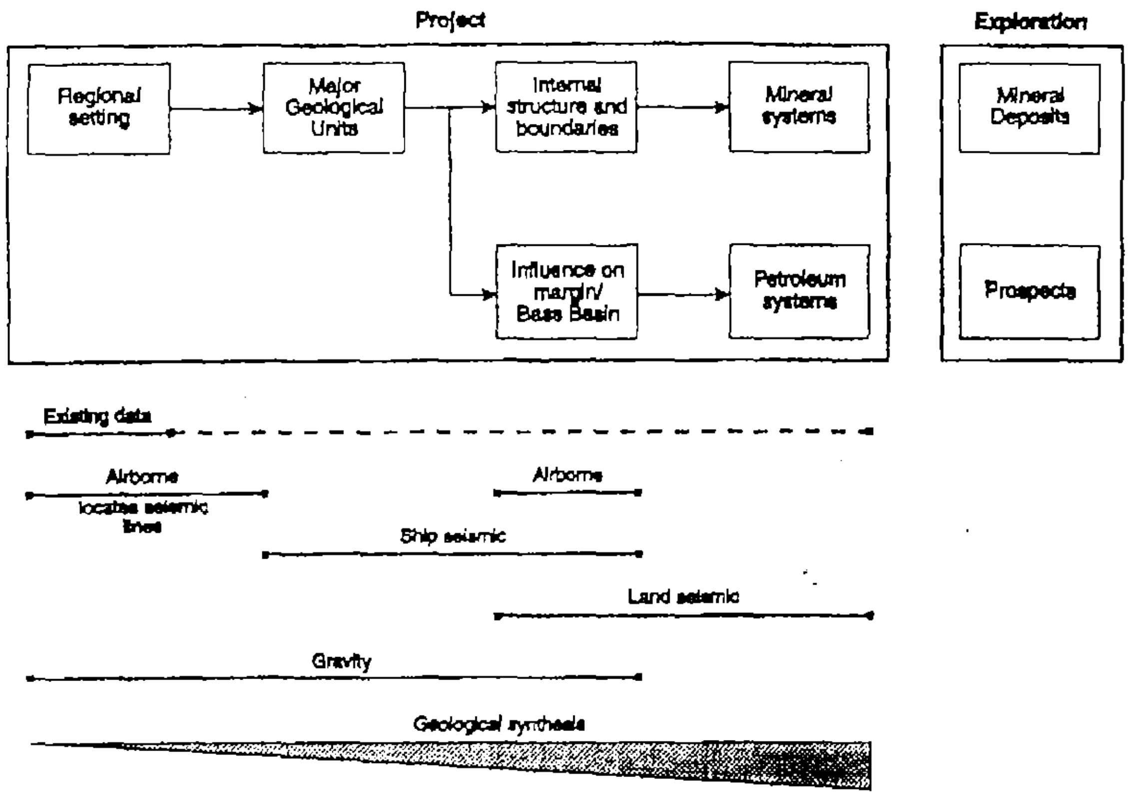


Fig. 1: Project Strategy

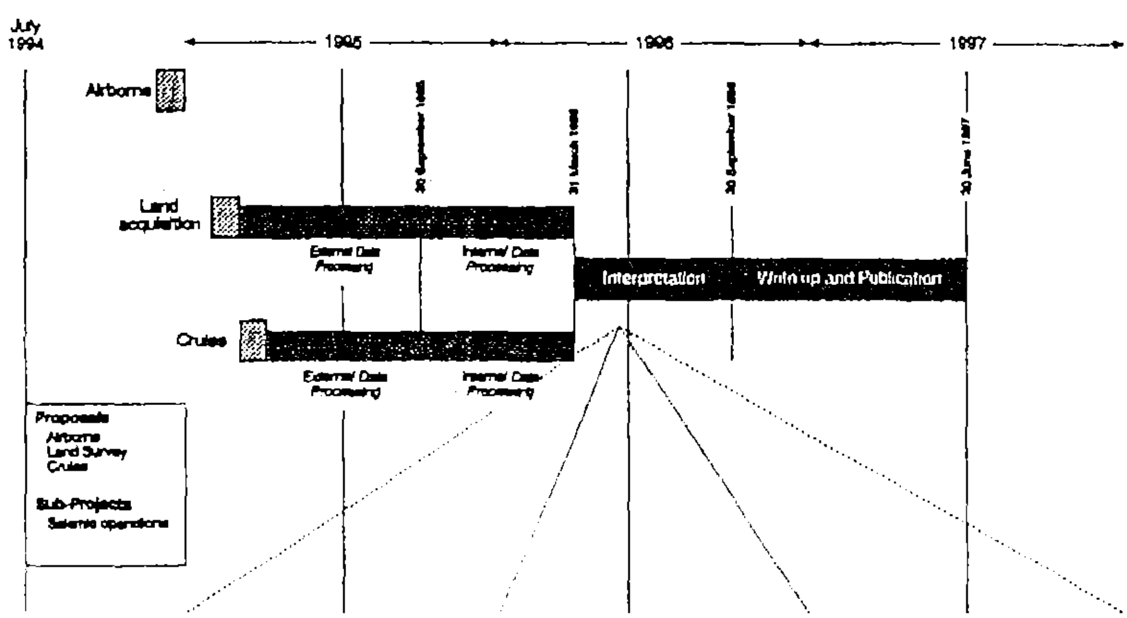
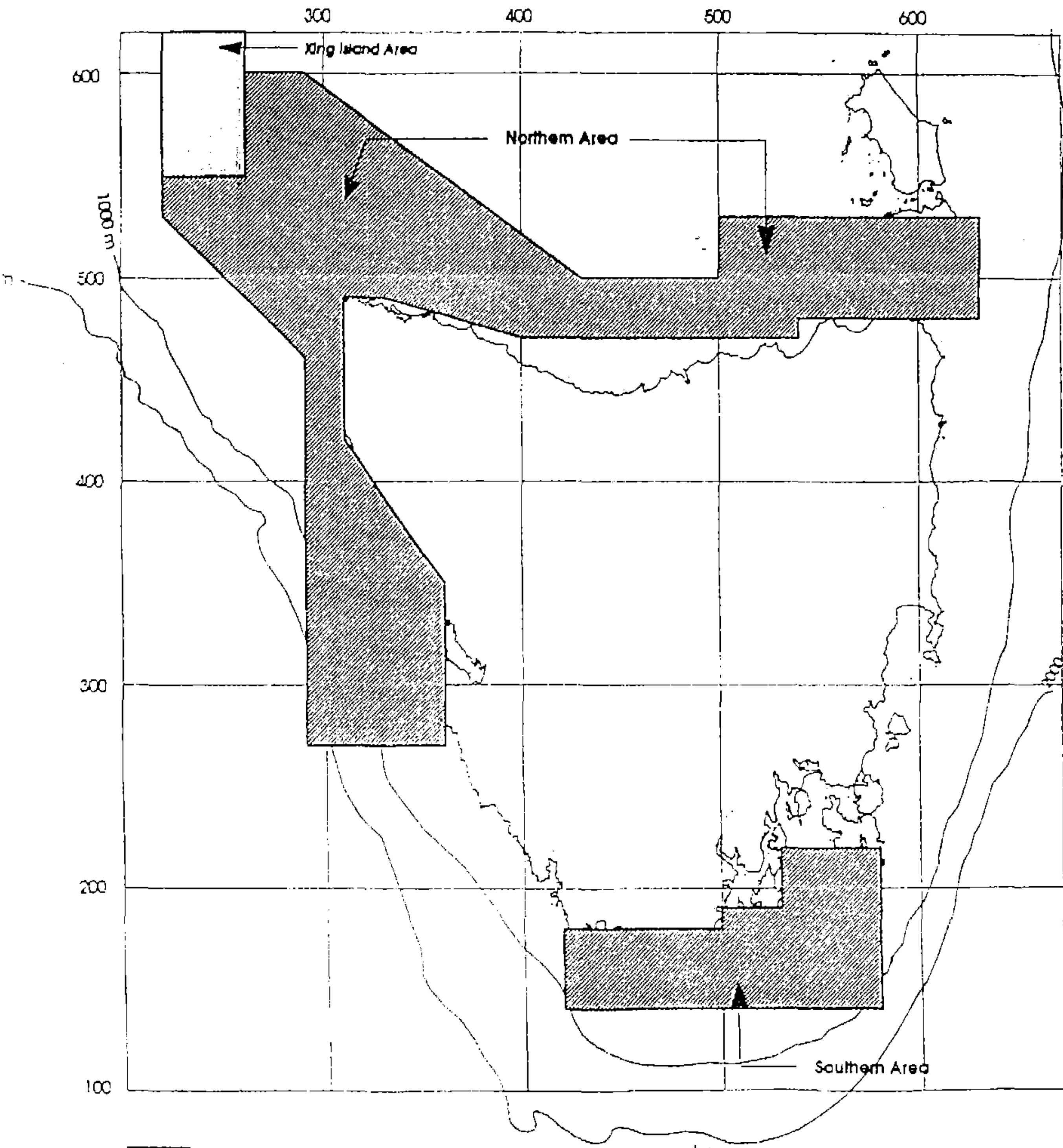


Fig. 2: Project Timetable

ATTACHMENT 2

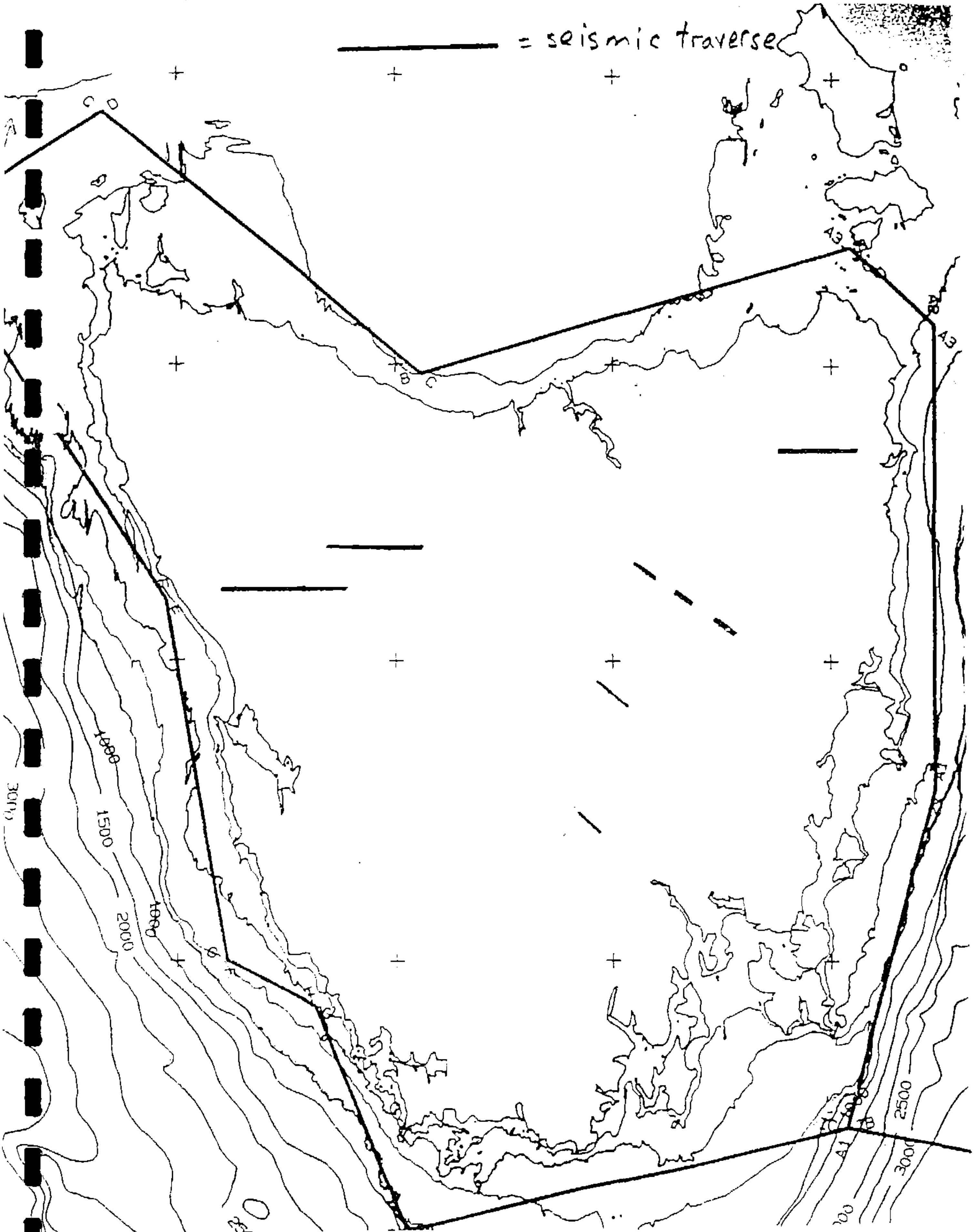
Figure 1 Areas to be covered by geophysical mapping program



800m Line Spacing aeromagnetics

400m Line Spacing aeromagnetics and γ ray spectrometry (King Island)

ATTACHMENT 3



TASMANIA DEVELOPMENT AND RESOURCES

Enquiries: Ms C A Bacon
Phone: (002) 33 8326
Your Ref:
Our File: CAB420.94:NW

14 November, 1994

Mr M Bendall
Director
Condor Oil Investments
84 Wells Parade
BLACKMANS BAY TAS 7052

Dear Sir

WORK PROPOSAL EL 1/88

Thank you for the report entitled 'Condor Oil Investments, North Bruny Island, a prognosis for a well'.

As discussed with the Registrar of Mines and myself on Thursday 10 November 1994, Mineral Resources Tasmania would be willing to consider approving the drilling of a stratigraphic borehole on Bruny Island under the same conditions as are required for drilling stratigraphic holes elsewhere in the State.

Your company should write to Mineral Resources Tasmania requesting approval to drill a stratigraphic hole. The work programme should include a signed statement from an acknowledged expert (such as your consultant Dr D E Leaman) that:

- The hole is to be a stratigraphic borehole to be drilled solely to obtain subsurface information on sediments, structure, etc.
- No specific petroleum/gas target or source is proposed.
- The likelihood of encountering gas or liquid hydrocarbons is no greater than in any other previously drilled stratigraphic hole in the south-eastern Tasmania region.

- In the opinion of the expert no blowout prevention equipment is necessary.

If there is any suggestion that Condor Oil Investments intend to drill any **other** sort of hole, or intend to drill for oil or gas or drill into a suspected petroleum reservoir than **all** the requisite provisions of Schedule C must be followed.

There is a considerable difference between drilling a hole **for oil or gas** and drilling a stratigraphic hole.

You have been advised previously that EL 1/88 will not be renewed unless the agreed work programme has been substantially completed by the renewal date of 31 December 1994.

This gives very little time to implement the proposed programme.

Yours faithfully

C A Bacon
MANAGING GEOLOGIST
HYDROCARBONS & TENEMENTS

EL 1/88

300237 84

CONDOR OIL INVESTMENTS PTY. LTD.

A.C.N. 055 403 515

84 Wells Parade
Blackmans Bay, Tasmania 7052

Telephone: 002 29 6576
Facsimile: 002 29 2153

MINES
EL1/88
22

Reg

15th November, 1994.

Mr. M.W.D. Ayre,
Director of Mines,
P.O. Box 56,
ROSNY PARK Tas. 7018

reports to go into CF

Dear Sir,

Please find attached copies of statements for the financial status of Condor Oil Investments Pty Ltd, a summary of previous work, a prognosis for a stratigraphic hole and notes on well pad specifications.

We have also attached copies of previous documentation related to earlier drilling proposals, equipment and expenditure.

The prognosis comments on drilling conditions. We draw attention to the type of hole envisaged and previous Tasmanian experience and request normal conditions of security, safety and specification for a deep diamond hole. Condor Oil notes that deep holes in Western Tasmania have encountered hydrocarbons but these have never caused problems and no special conditions are applied. Many of these holes are also much deeper.

We have the agreement of the property owner (R. Hazell) to drill at "Murrayfield" and now await your early approval to drill this stratigraphic hole.

We note that a bond with value greater than drilling cost has been mooted. We believe this to be inappropriate, especially given the losses forced on the company from previous proposals and restrictions. We believe the drilling should be encouraged under fair conditions. No reply has ever been received to correspondence concerning previous drilling proposals and associated losses.

The timing of this effort is of some concern. The company lost 4 months operation this year due to M.R.T. tendering process for surrounding areas. No financier would support the company until the issue of competition or re-acquisition could be settled. The commercial risks were too great.

Every effort is being made to drill this hold to the tenement schedule but it may not be possible, depending on your approval processes and rig availability.

Yours faithfully,

300238

CONDOR OIL INVESTMENTS PTY. LTD.

A.C.N. 055 403 515

84 Wells Parade
Blackmans Bay, Tasmania 7052

Telephone: 002 29 6576
Facsimile: 002 29 2153

19th November, 1994.

Ms Carol Bacon,
Mineral Resources Tasmania,
P.O. Box 56
ROSNY PARK Tas. 7018

Dear Carol,

Thank you for your attendance with myself, Dennis Burgess and Mr. Hazell on site, Murrayfield, Bruny Island, thursday November 17th, to inspect the site of shittim - 1, Condor's first stratigraphic well. Appendix (1) and (3) comply with your requests of your letter, dated 14th November, 1994, included as Appendix (2).

I note your comments that with the drilling of a purely stratigraphic well our current Bond of $30,000 is adequate and that once you had received Appendix (1) we would have automatic same day approval for our hole. Further, at your request, I have included a copy of the Notice of Intention to enter Private Land, given to Robert Hazell, with a copy of "Land Holders Position" as Appendix (4) which you will note Robert Hazell has signed.

I have also given Robert Hazell a copy of the relevant Drilling Pads Section of the Mineral Exploration Code of Practice Manual.

Tony Yeates, the Project co-ordinator for the "TASCO" 3 million dollar project (appendix 5) has also indicated that he views the drilling of shittim 1 as being vital to the processing of new seismic data and the possible re-processing of old data as it will provide the only down hole seismic in the State to calibrate the results correctly.

In regard to your comments on pre-collaring the first 100 metres of the hole, I would simply point out that at Smithton, where a 700 metre deep wild cat well for gas was put down by your Department on known gas seepages composed in part of explosive methane, without Blowout Prevention gear, on structure, the hole was pre-collared to a depth of 150 metres by a different rig to that used to drill the hole. It is standard industry practice as stated by ex Mines Department Chief Driller (Kerry Richardson) and Peter Sharp (Diamond Drilling Tasmania) to pre-collar deep

Diamond Drill holes as this practice greatly increases the chances of completing the hole successfully to target depth and also is quicker and half the cost of coring the first 100 metres.

In regard to the hole, shittim 1, the first 100 metres of geology is exposed and readily accessible in the outcrop at Variety Bay. In any case, no geological information not already known will be lost, as we are drilling to find out what we don't know, not that which is already known, it is logically the best practice to pre-collar. We will of course, as a matter of correct scientific procedure, collect the chip samples at three metre intervals, so as anybody interested in the hole may examine them.

Finally, I appreciated your comments that the Department wants this hole drilled as much as I do. I hope that a sorry series of events such as outlined graphically in my letter of the 15th November, 1994, are not allowed to re-occur. In the end, the people of Tasmania are the ones who will suffer from any continuing pedantic disputes between Condor and the Department.

You are also invited to attend an on site inspection with Peter Sharp and myself at a date to be arranged.

Yours sincerely,

MALCOLM BENDALL
MANAGING DIRECTOR

C.C. Robert Hazell
David Leaman
Kay Groom
Peter Sharp

300240

TASMANIA DEVELOPMENT AND RESOURCES

Enquiries: D R Burgess
Phone: (002) 33 8341
Your Ref:
Our File: DRB263.94:NW EL 1/88

21 November, 1994

The Chairman
Condor Oil Investments Pty Ltd
C/- G R Garrott & Co
Level 7, 39 Murray Street
HOBART TAS 7000

Dear Sir

PROPOSED DRILL HOLE - BRUNY ISLAND

Following the site visit by Carol Bacon and Dennis Burgess last week I am writing to express my serious concerns in regard to the quality of information that is being conveyed to Mineral Resources Tasmania by Mr Bendall the Principal Executive Officer of your company.

At a meeting in my office on 24 October 1994 Mr Bendall advised that a **concrete** drill pad was nearing completion at Bruny Island, on Mr Robert Hazell's property.

In a subsequent discussion with Ms Bacon and Mr Burgess, Mr Bendall stated that a compacted gravel drill pad had been completed together with a gravel area prepared for storage of drill pipes.

During the site visit on 17 November 1994 it was noted that no preparation work at all had been undertaken.

Mineral Resources Tasmania has been advised by Mr Bendall that he had arranged for drilling rigs to be on site at short notice.

The Registrar of Mines has spoken to both Mr Kerry Richardson and Mr Peter Sharpe in relation to availability of their drilling rigs.

Mr Richardson's rig is available at reasonably short notice but will not move on to the site unless payment is made up front. To date no specific date has been arranged.

HEAD OFFICE AND
DEVELOPMENT DIVISION
GPO Box 646 Hobart
Tasmania Australia 7001
22 Elizabeth Street Hobart
Tasmania Australia 7000
Tel: 002 33 5888 Fax: 002 33 5800

MINERAL RESOURCES TASMANIA
INDUSTRY SERVICES DIVISION
PO Box 56 Rosny Park
Tasmania Australia 7018
30 Gordons Hill Road Rosny Park
Tasmania Australia 7018
Tel: 002 33 8333 Fax 002 33 8338

The situation in regard to Mr Sharpe is more complex. He has been asked to provide a quote for a hole and is visiting the site during this week. However the Registrar was advised that no contract will be entered into until money outstanding from the Comstock Project is paid and sufficient money to cover the work is placed in a trust account.

In any case Mr Sharpe's rig is not available until May - July 1995 which is clearly at odds with comments from Condor Oil Investments Pty Ltd.

Apparently misleading statements by your Principal Executive Officer are not in the best interests of Condor Oil Investments Pty Ltd's dealings with this Agency.

In this regard I have clearly stated on several occasions that Mineral Resources Tasmania is supportive of genuine well managed exploration programs and have looked forward to progress on the work programmes committed to by your company.

Yours faithfully

M W D Ayre
DIRECTOR OF MINES

300242

LEAMAN GEOPHYSICS

Registered office:
3 MALUKA STREET. BELLERIVE. TAS. 7018
All correspondence to:
GPO BOX 320 D. HOBART. TAS. 7001
Telephone: (002) 44 1233
Fax: (002) 44 6674

November 21, 1994

Ms C A Bacon,
Managing Geologist,
Hydrocarbons and Tenements,
Mineral Resources Tasmania,
PO Box 56,
Rosny Park Tas 7018

Dear Ms Bacon,

Mr M Bendall, of Condor Oil, has asked me to prepare a statement about the objectives and needs of his proposed stratigraphic hole "SHITTIM 1" for you.
The following summary essentially restates what was included in my prognosis for this hole. That prognosis was prepared, and the hole specified, on the following bases only.

1. The hole is to be diamond-drilled at core sizes H or equivalent pre collar(near surface) and N (remainder).

2. It is to be drilled for stratigraphic purposes only and to permit geophysical logging and seismic velocity tests.

3. No specific hydrocarbon target is proposed or inferred; nor can any be defined at present.

4. There is no expectation that drilling characteristics in this hole, or hydrocarbon encounters, will differ in any material way from comparable stratigraphic holes previously drilled in SE Tasmania.

The prognosis fully discusses these issues.
Any major change, by the company or driller, of hole type (other than of any pre-collar), depth range, drilling method or objective might well change these presumptions. I have indicated to Mr Bendall that I would prefer he avoided the use of a pre-collar since some shallow information might be lost in the subsequent dependence on down hole logging methods near surface. Full chip samples should be retained if a pre-collar is drilled.

Yours faithfully,

D Leaman

Dr. D.E. Leaman

TASMANIA DEVELOPMENT AND RESOURCES

Enquiries: Ms C A Bacon
Phone: (002) 33 8326
Your Ref.
Our File: CAB440.94:NW

23 November, 1994

Mr G R Garrott
Chairman
Condor Oil Pty Ltd
C/- Level 7, 39 Murray Street
HOBART TAS 7000

Attention: Mr M Bendall

Dear Sir

PROPOSED PROGRAMME EL 1/88

Thank you for your letters of 15 November 1994 and 19 November 1994.

With reference to these letters the following points should be noted.

- EL 1/88 was renewed to 31 December 1994 on the basis of a work programme which included, amongst other activities, the drilling of two oil/gas wells by October 1994, and on the same programme one well was proposed for EL 17/90.

- The request for an increased bond as based on this work programme.

- The renewal of EL 1/88 was quite separate from the acceptance of Exploration Licence Application 10/94, to which we did agree to add the relinquished portion of EL 1/88 following the expiry of the Exploration Tender period. We have made the fact quite clear that EL 1/88 and EL 17/90 will **not** be renewed if the work programmes for the current renewals are not completed and that ELA 10/94 is being held pending satisfactory work on EL 1/88. The renewal of EL 1/88 was delayed for some months pending payment of the annual rent.

300244

- The request to drill a stratigraphic hole has only been made recently. A stratigraphic hole would be very useful in expanding the geological knowledge of the south eastern part of Tasmania and Mineral Resources Tasmania is fully supportive of the collection of this data.

By way of a considerable concession, we have been willing to alter the work programme commitment on EL 1/88 for two wells (drilled into an oil/gas targets) to a stratigraphic hole, drilled some kilometres from the original proposal, and which is designed only to collect geoscientific data.

The original work programme outlined a timetable whereby three wells would be drilled by September 1993 on the two exploration licences. Virtually no work at all which is outlined on the 1993-94 work programme has been completed to date.

However, with only a month or so left before the expiry of EL 1/88 your request to drill a stratigraphic hole has been presented to us.

On consideration of the proposal I am prepared to grant approval for the drilling of one stratigraphic hole on Murrayfield, Bruny Island, on the clear and unequivocal understanding that:

- The hole is to be diamond drilled at core sizes H or equivalent pre collar (near surface) and N (remainder).

- It is to be drilled for stratigraphic purposes only and to permit geophysical logging and seismic velocity tests.

- No specific hydrocarbon target is proposed or inferred; nor can any be defined at present.

- There is no expectation that drilling characteristics in this hole, or hydrocarbon encounters, will differ in any material way from comparable stratigraphic holes previously drilled in south east Tasmania.

- The work must be conducted in accordance with the Mineral Exploration Code of Practice.

- The hole must be capped on completion.

- Should groundwater be encountered steps must be taken to ensure there is no pollution of this resource and in the event that the groundwater flows from the hole (artesian conditions) then measures must be taken to permanently cap and contain this resource.

Please note that in allowing Condor Oil Pty Ltd to change the work programme for two oil wells to one stratigraphic hole represents a significant concession, which we have made in the interests of furthering the geological knowledge of the State.

I am also aware that the rig suggested for this work is, according to our information, unavailable until next May.

You should also be aware that spudding this drill hole, and drilling to 100 metres as a pre-collar will not satisfy the terms of your work programme, and if this is all that has been done by 31 December 1994 your renewal of the licence will not be recommended.

Yours faithfully

M W D Ayre
DIRECTOR OF MINES

RECORD OF TELEPHONE CONVERSATIONS WITH MR. DENNIS BURGESS ON THURSDAY, 24TH NOVEMBER, 1994.

PHONE CALL 1. THIS CALL WAS FROM DENNIS SAYING THAT MALCOLM HAD RUNG MR. AYRE AND THAT AS MR. AYRE WAS BUSY WITH HIS NEW APPOINTMENT WITH THE DEPARTMENT OF LABOUR AND INDUSTRY, DENNIS HAD BEEN ASKED TO CONTACT MALCOLM. I TOLD HIM I WOULD PASS HIS MESSAGE ON TO HIM.

PHONE CALL 2. DENNIS RANG, IN AN AGITATED STATE, TO SAY THAT THE PREMIERS DEPARTMENT HAD RUNG HIM STATING THAT MALCOLM HAD TOLD THE PREMIERS OFFICE ABOUT THE GAS SHOWS IN THE STRATIGRAPHIC HOLES BEING DRILLED ON BRUNY ISLAND. I REPLIED THAT THAT WAS WHY MALCOLM WANTED TO SPEAK TO MR. AYRE, AND WHEN HE WAS NOT AVAILABLE HE SPOKE TO THE MINISTERS OFFICE.

1. I CONFIRMED THAT MALCOLM HAD STRUCK GAS IN TWO HOLES WHILST HE WAS DRILLING A STRATIGRAPHIC HOLE. HE ASKED IF HE HAD AUTHORITY TO PROCEED, AND I TOLD HIM THAT CAROL BACON HAD SET THE REQUIREMENTS THE PREVIOUS WEEK, AND THESE HAD ALL BEEN MET. MR. AYRE SUBSEQUENTLY CONFIRMED THE AUTHORISATION.

2. DENNIS ALSO ASKED WHO WAS DRILLING THE HOLES, AND WHEN I SAID 'RICHARDSON' HE SAID 'WHAT, KERRY RICHARDSON' I SAID 'YES, SHARP WAS NOT AVAILABLE UNTIL NEXT MAY AND KERRY SAID HE COULD START STRAIGHT AWAY'. DENNIS SEEMED SURPRISED.

3. DENNIS SAID THAT HE WAS CONCERNED THAT MALCOLM LIED TO HIM ABOUT ROBERT HAZELL HAVING BUILT A DRILL PAD ON BRUNY ISLAND. I SAID I THOUGHT IT HAD BEEN DONE, BUT DENNIS SAID THAT IT NOT BEING DONE HAD REFLECTED ON MALCOLMS CREDIBILITY. I MADE NO COMMENT, EXCEPT TO SAY THE GAS SEEP IN 'SHITTIM 1' AND THE HEAVY DISCHARGE FROM 'GILGAL 1' WERE REAL AND COULD BE VERIFIED. HE QUESTIONED WHETHER WE EXPECTED TO HIT OIL OR GAS WITH THESE HOLES, AND I TOLD HIM WE WERE VERY SURPRISED BY THESE SHOWS, AS WE WERE DRILLING ON SITES SELECTED BY DAVID LEAMAN AS BEING STRATIGRAPHIC HOLE SITES SITUATED SEVERAL KILOMETRES FROM ANY 'TARGET' AREAS.

DENNIS FORCEFULLY SUGGESTED WE CEASE DRILLING FORTHWITH, AND I REPLIED THAT DRILLING HAD STOPPED THE PREVIOUS DAY AND THAT MALCOLM WAS DEVOTING ALL OF HIS TIME CONTROLLING THE GAS FLOWS, ESPECIALLY FROM 'GILGAL' 1 WHICH, ALTHOUGH BEING CONTROLLED BY THE APPLICATION OF WATER, WAS BEING CASED IN CONCRETE TO MAKE IT SAFE.

DENNIS SAID THERE WAS TO BE NO MORE DRILLING UNTIL A BLOWOUT PREVENTER WAS FITTED TO THE DRILL. I REPLIED THAT I WOULD PASS HIS COMMENTS ON TO MALCOLM.

D Bendall.

DAVID BENDALL

300248

TASMANIA DEVELOPMENT AND RESOURCES

Enquiries: D R Burgess
Phone: (002) 33 8341
Your Ref:
Our File: DRB280.94:NW EL 1/88

28 November, 1994

To MALCOLM BENDALL
No. FAX NO 292153
Company
From G. R. Garrott
Company
No. of Pages 1 Date 2/12/94

FAX URGENT Post-it Notes

Mr G Garrott
Chairman
Condor Oil Pty Ltd
C/- Level 7, 39 Murray Street
HOBART TAS 7000

Attention: Mr M Bendall

Dear Sir

PROPOSED DRILL HOLE - BRUNY ISLAND

I note recent comments made to the Minister for Mines that signs of oil and gas have been evident in two percussion drill holes on 'Murrayfield' Bruny Island.

Whilst questioning the significance of the results I now have no option other than to require your full compliance with the provisions of Schedule 'C' from this point on.

Specifically completion of SHITTEM1 can take place only with blowout prevention equipment in place as provided by that Schedule.

Yours faithfully

M W D Ayre
DIRECTOR OF MINES

Rec'd 2/12/94

300249

G. R. Garrott & Co.

Chartered Accountants

Geoffrey R. Garrott F.C.A.
Telephone: (002) 34 6533
(002) 34 6060
Fax: (002) 31 2805

7th Level, T.B.T. Building, 39 Murray Street, Hobart 7000

GRG:sg

2nd December 1994

Mr. M.W.D. Ayre
Director of Mines
P O Box 56
ROSNY PARK, TAS 7018

Dear Sir,

CONDOR OIL INVESTMENTS PTY. LTD.

On 19th **Nov**, the Managing Director, M. Bendall, indicated clearly Condor's intention to commence drilling on Shittim 1. The appendix to that letter were all the pre-requisite requirements including notification to the property owner (refer letter dated 19.11.94).

This drill hole was clearly commenced with a drill rig operated by K.M.R. Drilling on Monday 21st November, 1994. This drill rig is capable of coring an NQ stratagraphic hole as specified in the document forwarded to you "A prognosis for a Stratagraphic Hole".

The Managing Director advises that he was instructed by Mr. D. Burgess to cease drilling, due to unidentified gas inflow into the holes, and that the drill rig be moved off site.

These instructions appear to have been officially confirmed by your Department as per your letter dated 28th November, 1994 and received by me today (2nd December, 1994). This letter states that blowout prevention equipment is required, which is conflicting with advice which was acted upon in commencing the drilling programme.

Condor has therefore been compelled to curtail its drilling programme, on your instructions. Condor is well advanced to complete the Shittim 1 stratagraphic hole, having secured the supply of blowout prevention equipment, drilling quotation for services, drilling engineer, ancillary personnel and support.

The financing for this drilling programme has been arranged subject to security of tenure.

It is this security of tenure which is required to complete Condor's drilling requirements, which had been planned to be completed by 31st December 1994, and I understand that a drill rig had been reserved for this purpose.

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Condor will now possibly be unable to complete this work by 31st December 1994, in view of the Department's new requirements.

If these requirements are reasonable, the drilling programme should be completed within six weeks of notification.

Yours faithfully,

CHAIRMAN OF DIRECTORS

Appendix 7

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From Max Harvey Almac Drilling A.C.N. 067 140 318

Attention Malcolm Bendal

Dear Malcolm,

Thank you for a copy signed contract from the Trial Harbour mining Company concerning the proposed Stratigraphic Hole on Bruny Island.

I have been in Orange for the express reason of locating and finalising purchase and delivery of 1 Longyear 44 Drill rig and shall be able to put this machine on site by 14th February 1995.

I shall accept your proposal to Drill from 500m to 1000m under the same terms and conditions originally proposed by and to London oil Investments.

Yours Sincerely

Max Harvey