AGSO

CENOZOIC COOL-WATER CARBONATES OF THE GREAT AUSTRALIAN BIGHT: reading the record of Southern Ocean evolution, sealevel, paleoclimate, and biogenic production.

PROPOSAL 367-Rev3
DECEMBER 1995

*BY D.A. FEARY, N.P. JAMES,
B. McGOWRAN & P.L. SMART*

RECORD 1995/78

AGSO

AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION

AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION

Division of Marine, Petroleum, and Sedimentary Resources

AGSO Record 1995/78

CENOZOIC COOL-WATER CARBONATES OF THE GREAT AUSTRALIAN BIGHT: reading the record of Southern Ocean evolution, sealevel, paleoclimate, and biogenic production

PROPOSAL 367-Rev3
DECEMBER 1995

David A. Feary
Australian Geological Survey Organisation
Department of Geology & Geophysics
University of Sydney
Sydney NSW 2006
Australia

Noel P. James
Department of Geological Sciences
Queen's University
Kingston, Ontario K7L 3N6
Canada

Brian McGowran
Department of Geology & Geophysics
University of Adelaide
Adelaide SA 5005
Australia

Peter L. Smart
Department of Geography
University of Bristol
University Road
Bristol, BS8 1SS
U.K.

DEPARTMENT OF PRIMARY INDUSTRIES AND ENERGY

Minister for Resources: Hon. David Beddall, MP
Secretary: Greg Taylor

AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION

Executive Director: Neil Williams

ISSN: 1039-0073
ISBN: 0 642 22385 8

CONTENTS

FIGURES

PREFACE TO PROPOSAL 367-Rev3

This proposal should be read in conjunction with Proposal 367-Rev2 (AGSO Record 1994/62), assessed and ranked in Spring 1995, which contains the fundamental statement of scientific objectives. This present submission is a minor upgrading of Proposal 367, to address questions and weaknesses identified during panel reviews in the Spring 1995 round. In particular, this submission contains substantially revised sections on the fluid flow/diagenetic and biostratigraphic scientific objectives, and in addition addresses a range of technical and operational issues raised by panels.

We also present the original abstract for completeness, and full drill-site descriptions. Note that we follow the new drill-site nomenclature recommended by the JOIDES Office, so that sites retained from Proposal 367-Rev2 (AGSO Record 1994/62) are designated as 'A' sites (GAB-01A, GAB-03A etc), whereas sites moved or added as a result of panel recommendations are designated 'B' sites (GAB-02B, GAB-05B etc).

The advice from ODP-TAMU that there is likely to be a revision of the minimum safe working depth limit of the *Joides Resolution* from 50 m to 75 m arrived as this revision was in the final stages of preparation. This has implications for the three sites located in 50-52 m water depth. We have retained these sites in this revision, as they include fundamental scientific objectives of this proposal. However, we recognise that PCOM may determine that these sites may not be drillable with the *Joides Resolution*. In this case, we will have to identify an alternative drilling platform (and additional funding), so that drilling may occur in two stages (cf. New Jersey margin). We have also reinstated a further deep-water paleoceanographic site (GAB-13A) as a replacement for the shallow sites, designed to recover a Cretaceous and condensed Cenozoic section recording the history of CCD fluctuations and a partial history of deep water mass variations during evolution of the Southern Ocean.

ABSTRACT

This proposal advocates the drilling of a transect of holes across the southern continental margin of Australia; the largest cool-water carbonate shelf on Earth today. This latitude-parallel shelf along the northern margin of the Southern Ocean contains fundamental geological and paleoceanographic information of global geodynamic, sedimentological, paleobiological, and paleoclimatological importance. The major objectives of this proposal are: 1) to ascertain the way in which a large, high- to mid-latitude shelf carbonate platform evolved throughout the past 65 m.y. in response to oceanographic and biotic change; and 2) to extract information contained in the carbonate sediments detailing global sealevel fluctuations, physical and chemical paleo-ocean dynamics, biotic evolution, fluid flow, and diagenesis. Furthermore, because of architectural and compositional similarities with many older Phanerozoic carbonate platforms, the results from the proposed drilling would be of tremendous importance for the actualistic modelling of ancient open platforms and ramps.

Offshore seismic data and limited drillhole information indicate that the margin has been the site of dominantly cool-water carbonate shelf deposition since the Eocene, and displays a detailed accretionary history of progradation, erosion, and biogenic mound growth. The subsidence history is relatively simple, resulting in an $\approx$1 km-thick Cenozoic section. Onshore exposures provide a basis for predictive analysis of the offshore sequences identified in seismic sections, and confirm that the sediments are predominantly soft, friable, and abundantly fossiliferous.

A shallow shelf to deep continental rise transect of 13 sites is proposed, located to penetrate inner shelf, outer shelf, upper slope, upper slope terrace, and continental rise settings. The primary drilling objective is a more detailed understanding of global environmental change in high- to mid-latitude settings. Cores from different facies at various depths during a range of geologic periods will yield the detailed anatomy of a Cenozoic cool-water carbonate shelf. The response of this depositional system to inferred sealevel fluctuations will be compared to records from warm-water, rimmed and un-rimmed carbonate platforms in order to test and refine the global sealevel curve, and most importantly to describe the reaction of cool-water carbonate depositional systems to different phases of the sealevel cycle. Biological and chemical paleoenvironmental proxies will be used to decipher a detailed paleoceanographic record, in order to more precisely describe the timing and paleoceanographic effects of the opening of the Tasman Gateway, and the influence of the Leeuwin Current on paleoproductivity over time. The shelf-to-basin transect will also provide high resolution data on the tempo and pattern of biotic evolution in oceanic and neritic environments.

Secondary objectives are directed towards understanding the hydrology of a carbonate platform adjacent to a vast inland karst with sluggish water circulation; and the nature of early burial diagenesis (lithification and dolomitization) in a cold, seawater-dominated system.

1. ADDITIONAL STATEMENT OF SCIENTIFIC OBJECTIVES

1.1 DIAGENETIC PROCESS AND FLUID CIRCULATION OBJECTIVES

1.1.1 Limitations of Previous Diagenetic Studies

Our understanding of early carbonate diagenesis comes largely by inference from the older rock record (Tucker and Wright, 1991); from uplifted Cenozoic limestones (for instance on Barbados; Harrison, 1975); and from limited drilling and exploration of modern carbonate platforms, such as the Bahamas (Vahrenkamp, 1991; Whitaker et al., 1994; Melim et al., 1995) and atolls (Saller, 1984, Aissaoui et al., 1986). However, there is now general recognition that there have been systematic variations through geological time in original mineralogy and platform architecture associated with changes in ocean chemistry (Sandberg, 1983; Wilkinson et al., 1985); the dominant organisms present (Wilkinson, 1979; James, 1983); and the paleolatitude of deposition. Accordingly, earlier modern studies can provide misleading and incomplete analogues for many ancient carbonates because:

1) They are largely confined to chlorozoan warm-water carbonates which contain a high proportion of metastable aragonite, whose subsequent stabilisation gives rise to early calcite cementation. In contrast, calcitic sediments predominate at many times in the geological past.

2) They are often from steep-sided, isolated platforms lacking extensive continental hinterlands, or shelves with mountainous or terrigenous clastic coastlines. These architectures may give rise to a particular style and extent of circulation of diagenetic fluids. In contrast, circulation and diagenesis within ramps and epeiric platforms may be very different.

3) The Quaternary "Ice House" climate is associated with large amplitude oscillations in sea-level, which, on shallow, flat-topped, warm-water platforms result in prolonged exposure and predominance of meteoric diagenesis, but on inclined, cool-water ramps, lead to complex, recurring, meteoric/marine diagenesis, especially in mid- to deep-ramp facies.

The extensive cool-water carbonates on Australia's southern margin provide a unique opportunity to redress this imbalance, and may provide excellent analogues for diagenetic processes occurring in many calcitic Palaeozoic carbonate sequences.

1.1.2 Diagenesis of Cool-Water Calcitic Carbonates

As discussed more extensively in our earlier proposal (Feary et al., 1994), the Eucla Shelf is an open shelf to ramp type platform comprising bryomol cool-water carbonates with a predominantly calcitic mineralogy (James and Bone, 1991; James and von de Borch, 1991; James et al., 1994; Feary and James, 1995). Studies of comparable Cenozoic sediments, where exposed by upwarping on the continental margin (James and Bone, 1988) and elsewhere (Nelson et al., 1988; Reeckmann, 1988), demonstrate a radically different pattern of diagenesis to that of tropical aragonitic carbonates. Slow sedimentation permits sea-floor lithification by intermediate-Mg calcite cements, but these appear to be volumetrically limited and localised to omission surfaces and hardgrounds which are ubiquitous in the inner platform. Indeed, both shallow marine and meteoric cements appear to be very sparse, magnesium being lost from high-Mg calcite during grain recrystallization to low-Mg calcite. Sparse calcium-rich dolomites may be present (Reeckmann, 1988; Bone et al., 1992), and at some locations replacement can be pervasive (James et al., 1993), although the fine subtidal evaporation-related dolomites typical of tropical platforms are absent. It is not known whether dolomitization is episodic, as recognised in other present-day platforms (Vahrenkamp, 1991, McKenzie et al., 1993), or occurred over extended time periods. Extensive cementation does not occur until depths in excess of 100 m (James and Bone, 1988; 500 m in the case of Nelson et al., 1988), when compaction and pressure dissolution occur, resulting in copious epitaxial, pore-filling, low-Mg calcite cements. It is not known if this process is limited to meteoric environments, or also occurs in marine porewaters. Because of the prolonged period since initial exposure, neither the rates, nor the environment of diagenesis, are well understood from existing diagenetic studies.

This diagenetic style parallels almost exactly that described from the Mississippian limestones of New Mexico (Meyers, 1978; Meyers and Hill, 1983; Meyers and Lohmann, 1985; Meyers, 1989; Frank and Lohmann, 1995) and South Wales (Hird and Tucker, 1988). These studies have been pivotal in introducing the modern diagenetic paradigm of cement sequences which can be linked to changing pore fluid composition during lithification and burial. Indeed, the recent reinterpretation of the isotopic evolution of these cements in terms of a linear mixing model (Frank and Lohmann, 1995) reflects the interpretation of cool-water carbonate diagenesis advocated by Rao (1990). However, despite these extensive studies, significant problems in interpretation remain, particularly with respect to the magnesium content and isotopic composition of the predominant calcite cements.

We believe that our proposed studies of the Eucla Shelf carbonates will provide new insights into diagenetic development of calcitic cements.

1.1.3 Groundwater Circulation and Diagenesis

Some diagenetic reactions occur under essentially closed-system conditions with low water/rock ratios (Banner and Hanson, 1990), eg., magnesium for dolomitization may be locally derived from stabilisation of high-Mg calcite (Swart and Guzikowski, 1988). However, because of the high depositional porosity of carbonate sediments and their susceptibility to dissolution, significant groundwater circulation can occur, and thus open-system diagenesis with high water/rock ratios may predominate. For instance, magnesium for dolomitization may be supplied by circulation of sea-water or Mg-rich brines (Vahrenkamp, 1991; Swart, 1993; Whitaker et al., 1994). Thus, in addition to depositional mineralogy and composition, the geochemistry of the fluid and the rate of supply of reactants and flushing of products are critical in controlling the extent and products of diagenesis (Buddemeier and Oberdorfer, 1986; Lohmann, 1988; Meyers, 1989; Banner and Hanson, 1990).

Circulation of fluids may be driven by differentials in hydraulic head resulting from contrasts in water surface elevation and density, the latter being determined by salinity and temperature (Simms, 1984; Whitaker and Smart, 1990). Simple conceptual models for such circulations have been derived for both rimmed carbonate platforms and ramps (Burchette and Wright, 1992; Whitaker and Smart, 1993), but evidence for the existence and nature of such circulations is limited to rimmed shelves (Kohout et al., 1977; Fanning et al., 1981); isolated platforms

(Aharon et al., 1987; Whitaker and Smart, 1993); the subaerial parts of ramps (Hanshaw and Back, 1980); and model studies (Wilson et al., 1990, Whitaker et al., 1995).

The high primary depositional permeability of winnowed grainstones of the Eucla Shelf, and the lack of early cementation, suggest that significant groundwater circulation may occur, at least at shallow depths. The drive for such a circulation may come from temperature contrasts between cool ocean waters and groundwaters warmed by geothermal heat flux (and possibly volcanics) within the shelf, and be concentrated on the shelf margin (Simms, 1984). Alternatively, despite inland aridity, recharge occurring over the vast continental hinterland may drive brackish to saline waters southward to discharge through the flooded shelf. Such a circulation has been recognised by James (1992), and is associated with cave development on the Nullarbor Plain (James et al., 1989). In contrast to the long-lived nature of the above systems, differences in sea-surface elevation, on and off the shelf, associated with regional wave build-up (Feary, 1995), current flow (Rockford, 1986), and atmospheric pressure system changes may cause pumping of marine waters into and out of the platform (Marshall, 1986).

1.1.4 Changes in Diagenesis with Time

Differences in the style and rate of groundwater circulation and the nature of pore fluids and diagenetic products will have resulted from some combination of:

- the changes in climate, sea-level, and oceanic currents which have affected the Eucla Shelf through geological time;
- the differences in the architecture of the platform evident from the seismic profiles (Feary and James, 1995);
- and probable changes in composition and mineralogy of the carbonates forming the different units (Rao and Amini, 1995; Feary and James, 1995). The Eucla succession, containing a warm-water, aragonite-rich Miocene interval sandwiched between older and younger cool-water, calcite-rich packages, provides a built-in test for models based on these parameters.

There are thus both opportunities to determine the present-day associations between groundwater circulation, fluid geochemistry, and diagenetic products, and by inference from the temporal and spatial distribution of ancient diagenetic components, those that have occurred under different conditions in the past. Accordingly, we believe that diagenetic and fluid circulation studies of the Eucla Shelf have the potential to provide fundamental insights into the diagenesis of cool-water, open-shelf carbonates which are direct analogues for comparable carbonate platforms which were ubiquitous during Palaeozoic and other times.

1.1.5 Specific Research Objectives

We plan to address the following questions in our study of diagenesis of the Eucla Shelf:

1. What is the relative importance of thermal, oceanographic (current/storm/wave), and continental (elevation and/or brackish buoyant circulation) drives for groundwater circulation?
2. What is the significance of mass transfer by groundwater (high water/rock ratio), compared to mineral stabilisation and pressure dissolution compaction (low water/rock ratio?) for cementation?

3. What is the difference in diagenetic evolution between shelf margin (ocean flushed?) and interior (closed or continental flushed?) ?
4. What is the difference between diagenetic evolution for perennially-flooded marine, briefly exposed, and long exposed parts of the Cenozoic sequence?
5. To what extent is diagenetic evolution dependent on sediment texture controlling flushing of pore fluids, and cement donor/recipient relations?
6. What is the contrast in diagenetic style between warmer (aragonitic) and cooler (calcitic) carbonate sediments?
7. Do biogenic mounds have a different diagenetic development when compared to adjacent sediments (influences of sediment texture, organic or inorganic composition)?
8. What is the style, lithotype association, spatial and temporal distribution, magnesium/fluid source, and stability/recrystallisation pattern of the dolomites that are present?
9. What is the significance of second- and third-order regression sequence boundaries for diagenetic development, maturation, and flushing of the shelf carbonates?
10. Is there any evidence of late cements associated with volcanic intrusion, or expulsion of formation waters from underlying clastic sediments?

1.1.6 Experimental Methodology and Approach

We adopt a unified tripartite approach to these diagenetic and fluid flow objectives:
1. **Petrographic and geochemical examination of cored carbonates** will give direct information on original lithology, texture and composition, the extent and nature of compaction, and the temporal distribution and composition of cements.
2. **Pore fluid geochemistry** will provide constraints on present-day fluid/cement relations and water/rock ratios and, where groundwater flow is significant, also diagnostic tracers of fluid source, evolutionary pathways, and residence times.
3. **Groundwater hydrology** may be determined from the distribution of temperature, conductance, and pressure head, and together with core permeability, permit numerical modelling of the extent, nature, and rate of hydrological circulation and geochemical mass transfer.

Geochemical parameters will include the standard suite of inorganic parameters, TOC, $\delta^{18}O$, $\delta^{13}C$ and $^{87}Sr/^{86}Sr$, on shipboard squeezed pore fluids (both lithified and unlithified), for comparison with the composition of allochems and cements. There is also potential for microbiological analysis of recovered carbonates, as a guide to active redox processes within the sediments.

We will use the vertical distribution of fluid composition below sea-floor to determine the degree of fluid-driven mass transfer, compared to diffusion-induced concentration differences. The rate of circulation may then be inferred from the extent of water/rock disequilibrium (McKenzie et al., 1993), and isotopic composition compared with the interglacial/glacial ocean water compositional changes (Paull et al., 1995). We also hope to utilise existing on-land geochemical data from caves (James, 1992) and drill holes (Lowry, 1970, supplemented as appropriate), to provide a continental end-member for both geochemical and groundwater hydrology aspects of the study.

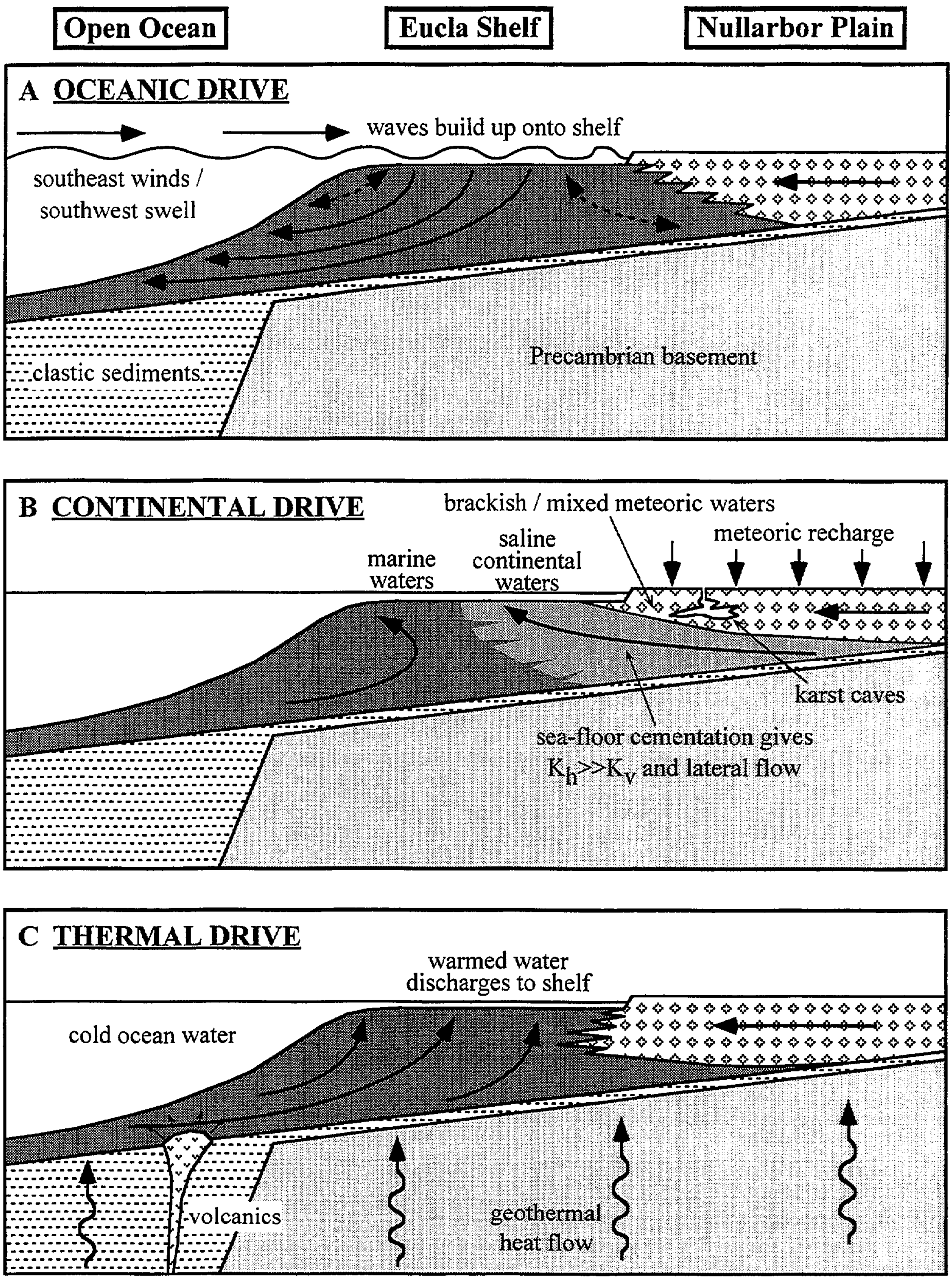


Figure 1. Cartoon showing three possible fluid circulation patterns within the Eucla Shelf sequences. None of these systems will operate in isolation, and circulation will be greatly affected by the distribution of permeable pathways within the carbonates. Note that broken arrows indicate reversing flow (pumping).

1.2 BIOSTRATIGRAPHIC FRAMEWORK OF CENOZOIC SEQUENCES IN THE GREAT AUSTRALIAN BIGHT

Proposal 367 seeks to drill seismically-defined sedimentary packages on the continental margin, and will date shelf-slope reflectors (second- and third-order sequence boundaries) with all possible geochronological methods. As well as contributing to our understanding of extratropical neritic carbonate environments in the sphere of influence of the Leeuwin Current, with its switch/on, switch/off links to the equatorial circulation system, success in this endeavour will have major implications for (i) patterns of eustatic change and their chronological relationship to oceanic patterns of climatic change (Miller, 1994), and (ii) understanding the evolution of the widening Southern Ocean, whose counterpart shelf-slope-ocean realm was at high latitudes. This note considers the present state of southern Australian biostratigraphy, and its applicability to sequences proposed for drilling in the western Great Australian Bight.

1.2.1 Biostratigraphic succession in southern Australia

Onshore, stage stratotypes and other outcrops are scattered geographically, and only partly represent the section stratigraphically. On this passive margin, sedimentary accumulations were usually thin, and deformation, subsequent inversion, uplift, and erosional exposure have all been slight. Thus, the known succession of biostratigraphic events is a highly composite reconstruction. Chaproniere et al. (1995) have made the most recent and comprehensive presentation of an integrated biostratigraphy for the Cenozoic. The major groups included are the calcareous nannofossils, planktonic foraminifers, and marine and terrestrial palynomorphs, successions for which are extracted from the Chaproniere et al. (1995) charts and shown here in Figure 2. Chaproniere et al. (1995) also include the succession of neritic mollusc assemblages, the Indo-Pacific letter "stages", the land mammal faunal associations and various ecostratigraphic events, and the regional stages of southeastern Australia (partially shown in Fig. 2).

The Chaproniere et al. (1995) compilation shows very clearly what we know and what we don't. There are three categories of obvious advances to be made: (i) filling in the regional biosuccessions and strengthening the cross-ties between them; (ii) correlating the terrestrial and neritic realms in southern Australia with the oceanic realm and with the standard integrated geochronology; and (iii) integrating the regional biostratigraphy into sequence stratigraphy. These are considered in turn:

1.2.2 The regional biosuccession

Figure 3 is a conventional correlation chart for the marine successions in southern Australia, showing the later Palaeogene and Neogene, i.e. the carbonate-rich section (marginal and nonmarine siliciclastics are mostly omitted). At this third-order scale, and on biostratigraphic evidence with virtually no other geochronological support, this diagram shows three chronostratigraphic packets of strata: later Eocene to early Oligocene; late Oligocene to Miocene; and Pliocene. These are sketched as second-order cycles in Figure 4. As can be seen from the correlations, they reflect the putatively global TA and TB cycles. The point here is that the quality of the biosuccession strongly reflects the second-order packets. Danian and Lutetian strata or fossils are not known at all (the carbonates of the Naturaliste Plateau provide some coccolith and foraminiferal events for the Lutetian), and the Rupelian and Tortonian are very restricted in their distribution.

The onset of carbonate accumulation (Wilson Bluff transgression, Bartonian, 41-42 Ma) is a biostratigraphic turning point. Below that horizon, shelf sediments are predominantly siliciclastics with marginal marine dinoflagellates, and punctuated by marine ingressions with poor macrofaunas and benthic and planktonic foraminiferal assemblages. This siliciclastic regime begins with the Ceduna transgression in the middle or late Maastrichtian, with a planktonic foraminiferal assemblage of about 15 species and a monospecific swarm of high-conical radiolarians (McGowran, 1991). It confirms the existence of the long and narrow Maastrichtian seaway postulated by Frakes et al. (1987). In the Paleocene to early Eocene, the recognised transgressions (Kings Park to Burrungule), containing distinctive foraminiferal assemblages, are found from the Great Australian Bight to the Otway Basin. We have no biostratigraphy for the middle Eocene (below the neritic carbonates), and all shelf facies below the carbonates and east of the Great Australian Bight are barren of calcareous nannofossils. Thus, offshore seismic sequence 7 may have a very restricted and culled microfossil assemblages in its siliciclastic component; but if sequence 7 is calcareous in part, then we can expect a major contribution to the regional biostratigraphy.

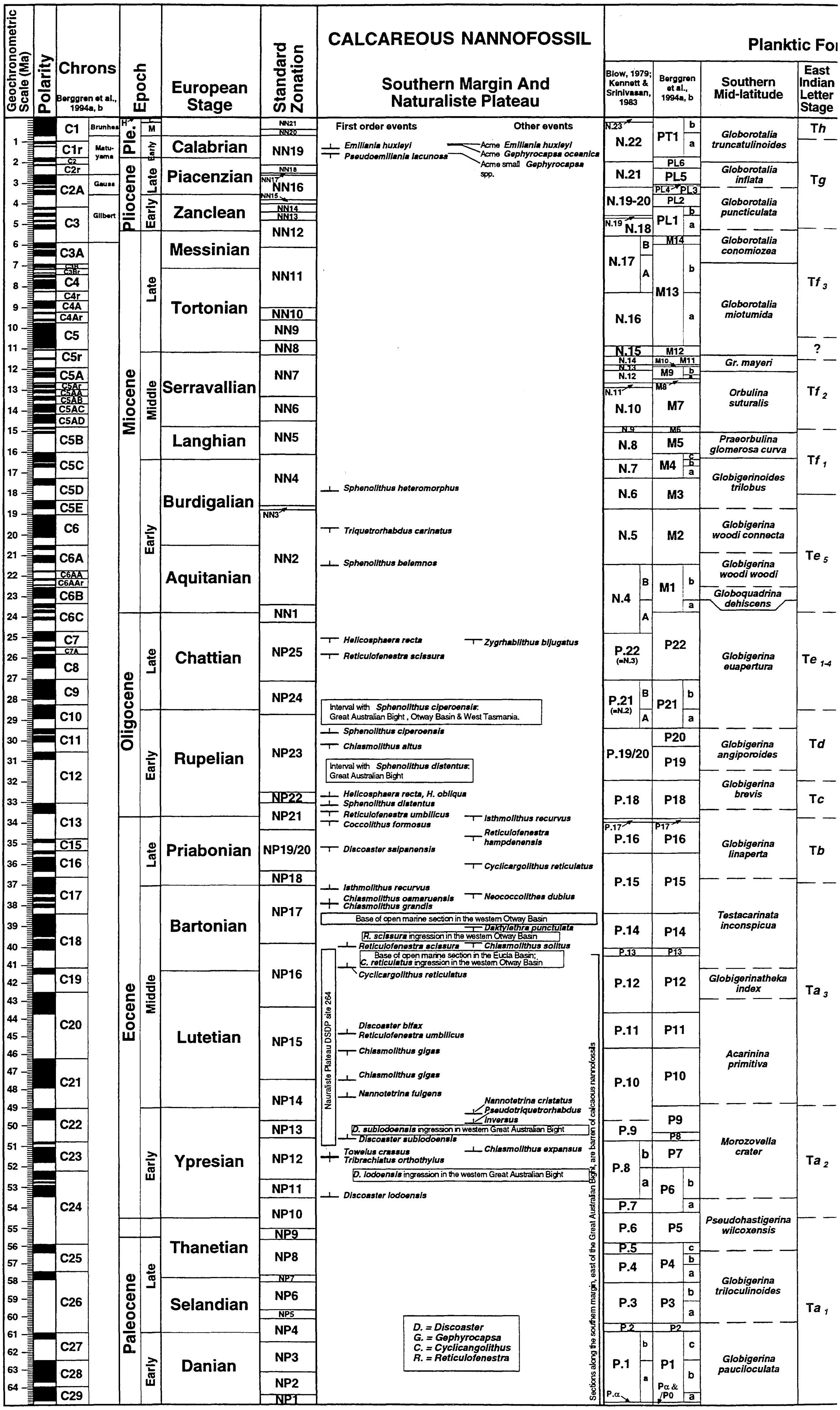
Offshore seismic sequence 6, in contrast, is predicted to span the range of neritic carbonates. The oceanic and austral influences will be strong, and there will be abundant ecostratigraphic fluctuations at the third- and fourth-orders, in response to oscillations in the position of the Subtropical Convergence, the on/off switching of the Leeuwin Current, and varying intensity of upwelling. Sequence 6 will be subdivided when its time comes. The main problem for biostratigraphy will be carbonate diagenesis, especially in rim facies originally with aragonitic components, but also in dolomitized intervals.

Offshore seismic sequences 1-5 bring us to the time of a scattered and poor regional biostratigraphic record. Although we are confident that siliciclastics will not have any significant diluting effect, it is likely that rather thin sequences on the shelf will be interrupted by hiatuses. For these intervals, we anticipate that the deeper water paleoceanographic sites (GAB-01A, GAB-02B, and GAB-13A) will provide critical components of the succession.

The biostratigraphy of the sections proposed for drilling will be based on the succession in Fig. 2. At the same time, though, drilling will have a major beneficial impact on the regional biostratigraphy. It will do this by adding a more oceanic component, increasing the density of bioevents, confirming their ordination, and making graphic correlation more useful.

1.2.3 Correlating terrestrial/neritic realms with oceanic realm and with standard integrated geochronology

There is very little work as yet on strontium, geomagnetic, or radiometric dating to support the rigorous correlation of biostratigraphic events with either extratropical oceanic successions or



Geochronometric Scale (Ma)
Polarity
Chrons
Berggren et al., 1994a, b
Epoch
European Stage
Standard Zonation
CALCAREOUS NANNOFOSSIL
Southern Margin And Naturaliste Plateau
First order events
Other events
Planktic Fo
Blow, 1979; Kennett & Srinivasan, 1983
Berggren et al., 1994a, b
Southern Mid-latitude
East Indian Letter Stage
C1
C1r
C2
C2r
C2A
C3
C3A
C3B
C3Br
C4
C4r
C4A
C4Ar
C5
C5r
C5A
C5Ar
C5AA
C5AB
C5AC
C5AD
C5B
C5C
C5D
C5E
C6
C6A
C6AA
C6AAr
C6B
C6C
C7
C7A
C8
C9
C10
C11
C12
C13
C15
C16
C17
C18
C19
C20
C21
C22
C23
C24
C25
C26
C27
C28
C29
Brunhes
Matu-yama
Gauss
Gilbert
H
Ple.
M
Early
Pliocene
Late
Early
Miocene
Late
Middle
Early
Oligocene
Late
Early
Eocene
Late
Middle
Early
Paleocene
Late
Early
Calabrian
Piacenzian
Zanclean
Messinian
Tortonian
Serravallian
Langhian
Burdigalian
Aquitanian
Chattian
Rupelian
Priabonian
Bartonian
Lutetian
Ypresian
Thanetian
Selandian
Danian
NN21
NN20
NN19
NN18
NN17
NN16
NN15
NN14
NN13
NN12
NN11
NN10
NN9
NN8
NN7
NN6
NN5
NN4
NN3
NN2
NN1
NP25
NP24
NP23
NP22
NP21
NP19/20
NP18
NP17
NP16
NP15
NP14
NP13
NP12
NP11
NP10
NP9
NP8
NP7
NP6
NP5
NP4
NP3
NP2
NP1
Emiliania huxleyi
Pseudoemiliania lacunosa
Acme Emiliania huxleyi
Acme Gephyrocapsa oceanica
Acme small Gephyrocapsa spp.
Sphenolithus heteromorphus
Triquetrorhabdus carinatus
Sphenolithus belemnos
Helicosphaera recta
Reticulofenestra scissura
Zygrhablithus bijugatus
Interval with Sphenolithus ciperoensis: Great Australian Bight, Otway Basin & West Tasmania.
Sphenolithus ciperoensis
Chiasmolithus altus
Interval with Sphenolithus distentus: Great Australian Bight
Helicosphaera recta, H. obliqua
Sphenolithus distentus
Reticulofenestra umbilicus
Coccolithus formosus
Isthmolithus recurvus
Reticulofenestra hampdenensis
Discoaster saipanensis
Cyclicargolithus reticulatus
Isthmolithus recurvus
Chiasmolithus oamaruensis
Chiasmolithus grandis
Neococcolithes dubius
Base of open marine section in the western Otway Basin
Daktylethra punctulata
R. scissura ingression in the western Otway Basin
Reticulofenestra scissura
Chiasmolithus solitus
Base of open marine section in the Eucla Basin; C. reticulatus ingression in the western Otway Basin
Cyclicargolithus reticulatus
Naturaliste Plateau DSDP site 264
Discoaster bifax
Reticulofenestra umbilicus
Chiasmolithus gigas
Chiasmolithus gigas
Nannotetrina fulgens
Nannotetrina cristatus
Pseudotriquetrorhabdus inversus
D. sublodoensis ingression in western Great Australian Bight
Discoaster sublodoensis
Towelus crassus
Tribrachiatus orthostylus
Chiasmolithus expansus
D. lodoensis ingression in the western Great Australian Bight
Discoaster lodoensis
Sections along the southern margin, east of the Great Australian Bight, are barren of calcareous nannofossils
D. = Discoaster
G. = Gephyrocapsa
C. = Cyclicangolithus
R. = Reticulofenestra
N.23
N.22
N.21
N.19-20
N.19
N.18
N.17
B
A
N.16
N.15
N.14
N.13
N.12
N.11
N.10
N.9
N.8
N.7
N.6
N.5
N.4
B
A
P.22 (=N.3)
P.21 (=N.2)
B
A
P.19/20
P.18
P.17
P.16
P.15
P.14
P.13
P.12
P.11
P.10
P.9
P.8
b
a
P.7
P.6
P.5
P.4
P.3
P.2
P.1
b
a
P.α
PT1
b
a
PL6
PL5
PL4
PL3
PL2
PL1
b
a
M14
M13
b
a
M12
M11
M10
M9
b
a
M8
M7
M6
M5
M4
c
b
a
M3
M2
M1
b
a
P22
P21
b
a
P20
P19
P18
P17
P16
P15
P14
P13
P12
P11
P10
P9
P8
P7
P6
b
a
P5
P4
c
b
a
P3
b
a
P2
P1
c
b
a
Pα & P0
Globorotalia truncatulinoides
Globorotalia inflata
Globorotalia puncticulata
Globorotalia conomiozea
Globorotalia miotumida
Gr. mayeri
Orbulina suturalis
Praeorbulina glomerosa curva
Globigerinoides trilobus
Globigerina woodi connecta
Globigerina woodi woodi
Globoquadrina dehiscens
Globigerina euapertura
Globigerina angiporoides
Globigerina brevis
Globigerina linaperta
Testacarinata inconspicua
Globigerinatheka index
Acarinina primitiva
Morozovella crater
Pseudohastigerina wilcoxensis
Globigerina triloculinoides
Globigerina pauciloculata
Th
Tg
Tf 3
?
Tf 2
Tf 1
Te 5
Te 1-4
Td
Tc
Tb
Ta 3
Ta 2
Ta 1

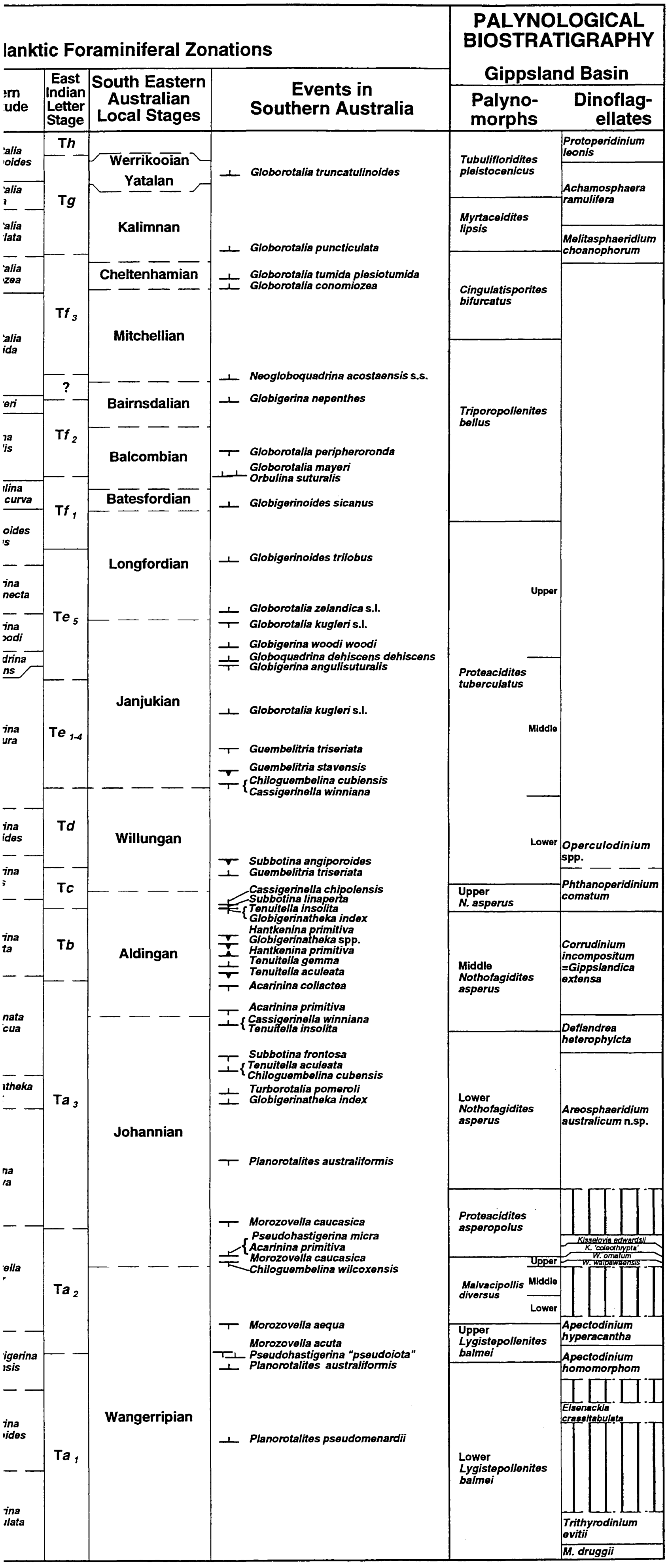


Figure 2. Cenozoic biostratigraphy in southern Australia; modified and simplified from comprehensive charts assembled by Chaproniere et al. (1995).

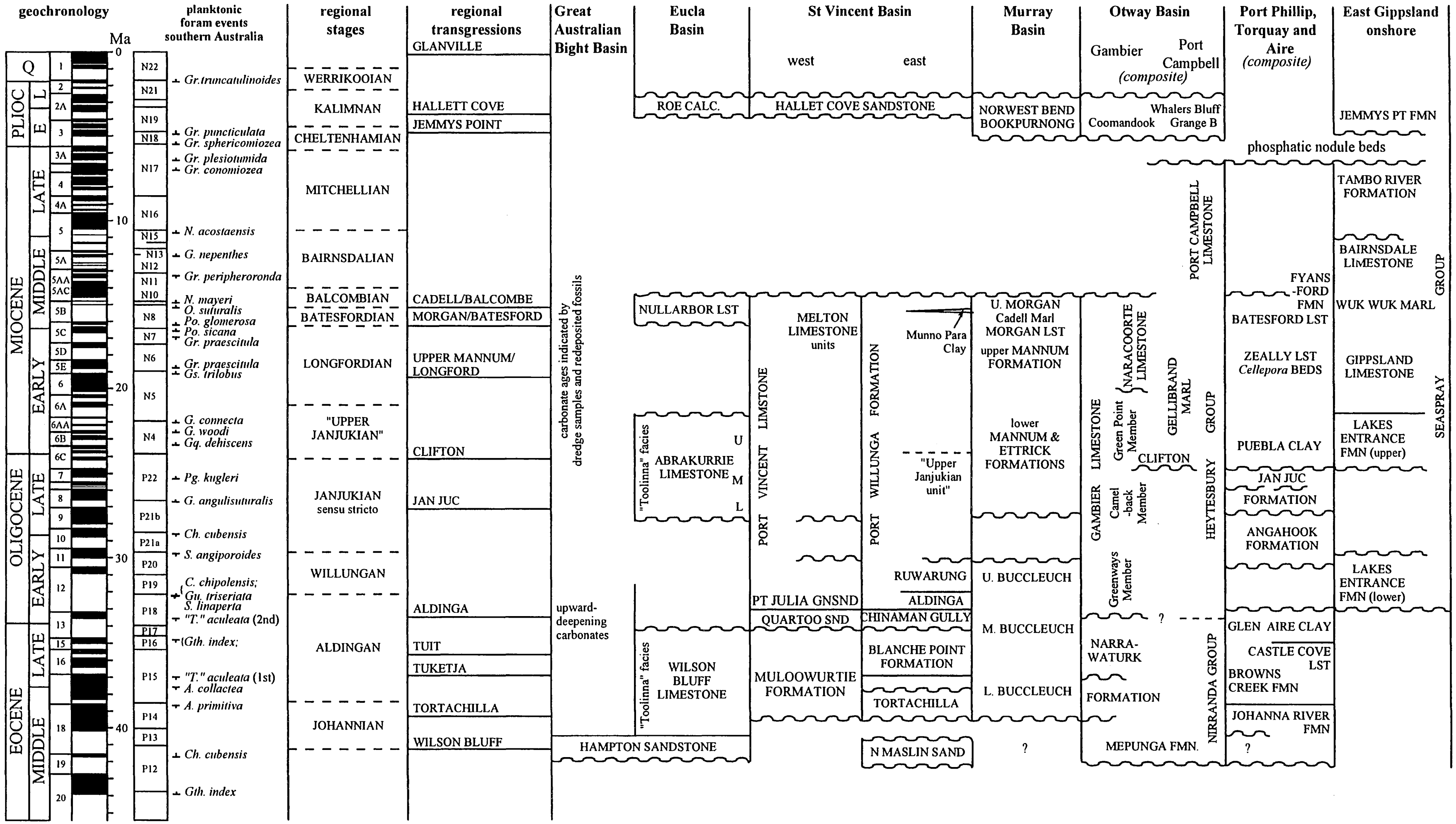


Figure 3. Correlations of later Paleogene and Neogene marine strata in southern Australia, with siliciclastics mostly omitted, from McGowran et al. (ms). Note the 'sudden' onset in the late middle Eocene and termination in middle Miocene; note also the parallelism in several hiatuses, consistent with available evidence but mostly not rigorously confirmed.

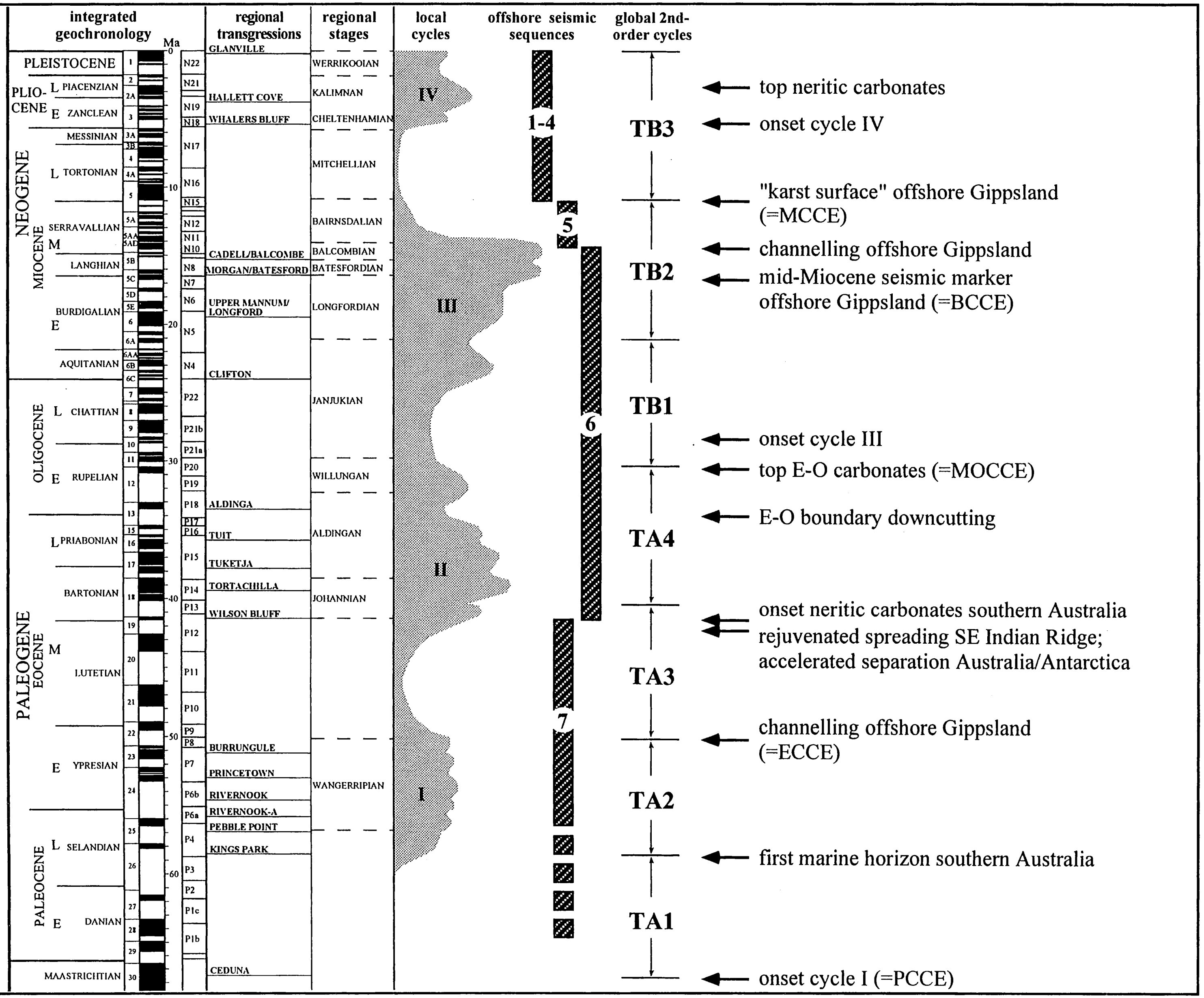


Figure 4. The four second-order sequences in southern Australia are sketched against regional stages and regional transgressions. The offshore seismic sequences are from Feary et al. (1994). Events listed at right are seen in one or more marginal basins. The Miocene events (MCCE, BCCE, MOCCE, ECCE and PCCE) are major canyon cutting events, from Bernecker et al. (ms).

the tropical standard. However, work now in progress is expected to change that situation soon (e.g. Arai et al., 1995).

1.2.4 Event stratigraphy, ecostratigraphy, sequence biostratigraphy

At the second-order, five offshore seismic sequences have been identified in the western Great Australian Bight, becoming the central theme of ODP Proposal 367. Figure 4 shows how they might match events in southern Australia. The "karst surface" in the offshore Gippsland Basin (Sanders and Steel, 1982; Bernecker et al., ms) is at the foot of the major fall in sea-level, and the onset of intense channelling is at the beginning of that fall. Thus we already have events from the opposite end of the southern margin to test. Seismic sequence 6 spans the Eocene-Miocene carbonate section (Fig. 3), and spans several horizons which should be sequence boundaries, serving as markers in onshore-offshore transects and thereby dividing sequence 6. The sequence 6/7 boundary would mark the major tectonic event in the region - the plate tectonic reorganization and the sudden onset of neritic carbonate accumulation.

Ecological patterns in time and space are a recently invigorated field of research (DiMichele, 1994). With a stratigraphic emphasis, these same patterns become the stuff of ecostratigraphy. Meanwhile, in sequence stratigraphy, packets of strata are found to be arranged in a coherent pattern, inferred to be related to global sea-level fluctuations. Since biofacies and sequences have a parallel hierarchical distribution against geological time scales, unifying the fields of ecostratigraphy and sequence stratigraphy is an exciting prospect! There has been some progress in relating biofacies and transgressions to putative sequences in the Lakes Entrance section through the Miocene in Gippsland (McGowran and Li, in press) and in the late Eocene to Oligocene in three basins (Moss, 1995). Neither exercise was supported by seismic sequences. Holdgate and Gallagher (ms) have identified third-order, seismically-defined sequences in the Gippsland Basin which extend from nonmarine coals to neritic carbonates. They have characterized the sequences in biostratigraphy and biofacies, and made reasonable correlations with the Exxon third-order succession, but not by integrated geochronology. Thus, all of this recent work lacks one ingredient or another essential to testing the notion of eustatically-controlled sequences on continental margins. However, we have an increasingly comprehensive ecostratigraphic profile of neritic foraminifera in place, supported by monographic studies (Moss, 1995, Li and McGowran, ms), and the onshore and neritic biostratigraphy, biofacies and seismic package analysis will be in a more mature state within two years.

1.2.5 Southern Ocean: biostratigraphy across the watergap

We have largely abandoned zones in southern Australian biostratigraphy. Although Jenkins (1993a,b) continued to use formally-defined zones (the southern midlatitude column in Figure 2 is from his work - Jenkins, 1985), and although southern Australia clearly is biogeographically austral, continued adjustments, especially by Jenkins himself but by others too, have encouraged the abandoning of local zones whilst the piecemeal accumulation of defining events and their correlation and numerical calibration proceeded. There has been a second reason for abandoning zones in southern Australia; too many "datums" are not first and last appearances. However, the cry of "diachronism!" (Jenkins, 1974) is an inadequate response. Instead, we see populations 'riding in' and 'riding out' on watermasses shifting on the grand scale, and there is no *a priori* criterion for distinguishing irreversible or orthochronological events from reversible events. The latter have to be set in a constraining framework consisting of the former, but our only tactic has been to determine which is which as the pattern clarifies. Thus, the continued fiddling with regional zonal definitions is confusing and misleading as well as unnecessary (which is not to imply that the *standard* zones should not be retouched from time to time, cf. the Berggren revisions of the P and N zones shown Figure 2). As we establish the "real" datums as controls, the repeated immigrations can be used for an ecostratigraphic fleshing out of the conventional biostratigraphy and integrated geochronology.

Wei (1992) and Huber and Watkins (1992) have demonstrated with magneto-chronological control that species' first and last appearances can be at different times in the Southern Ocean, implying some watermass control of immigration. However, diachronism can be challenged as a ruling paradigm on a grander scale, at least in the Paleogene. Figure 5 presents a very similar homotaxial succession of events for the southern extratropical realm. In the third-order window, there is little reason to question an essentially isochronous succession. Indeed, there are few events in common between the tropics and the higher latitudes, but there are several events in common among the southern regions. There is a succession of initial appearances that are in the right positions (*Planorotalites australiformis, Acarinina primitiva, Globigerinatheka index, Chiloguembelina cubensis*), as are several last appearances (*P. australiformis, A. primitiva, Subbotina angiporoides, Ch. cubensis*). The variations in position among last *G. index* and *Tenuitella insolita* at about the Eocene/Oligocene boundary are trivial, pending more work. Of the well-known events in the Austral region, the last occurrence of *Subbotina linaperta* is considerably earlier in Antarctica than elsewhere, but this is due to a taxonomic difficulty (iteration in the *linaperta-angiporoides* clade). Thus the independent correlations of southern Australia-New Zealand and Antarctica with the tropical standard reveals an impressive parallelism in the biostratigraphic succession. Contrast that situation with the situation in zonal nomenclature; there are no zones in common between Antarctica and New Zealand, and there are different intervals (and intervals overlapping only in part) bearing the same name, with the obvious potential for more confusion in communication than if we stick with datums.

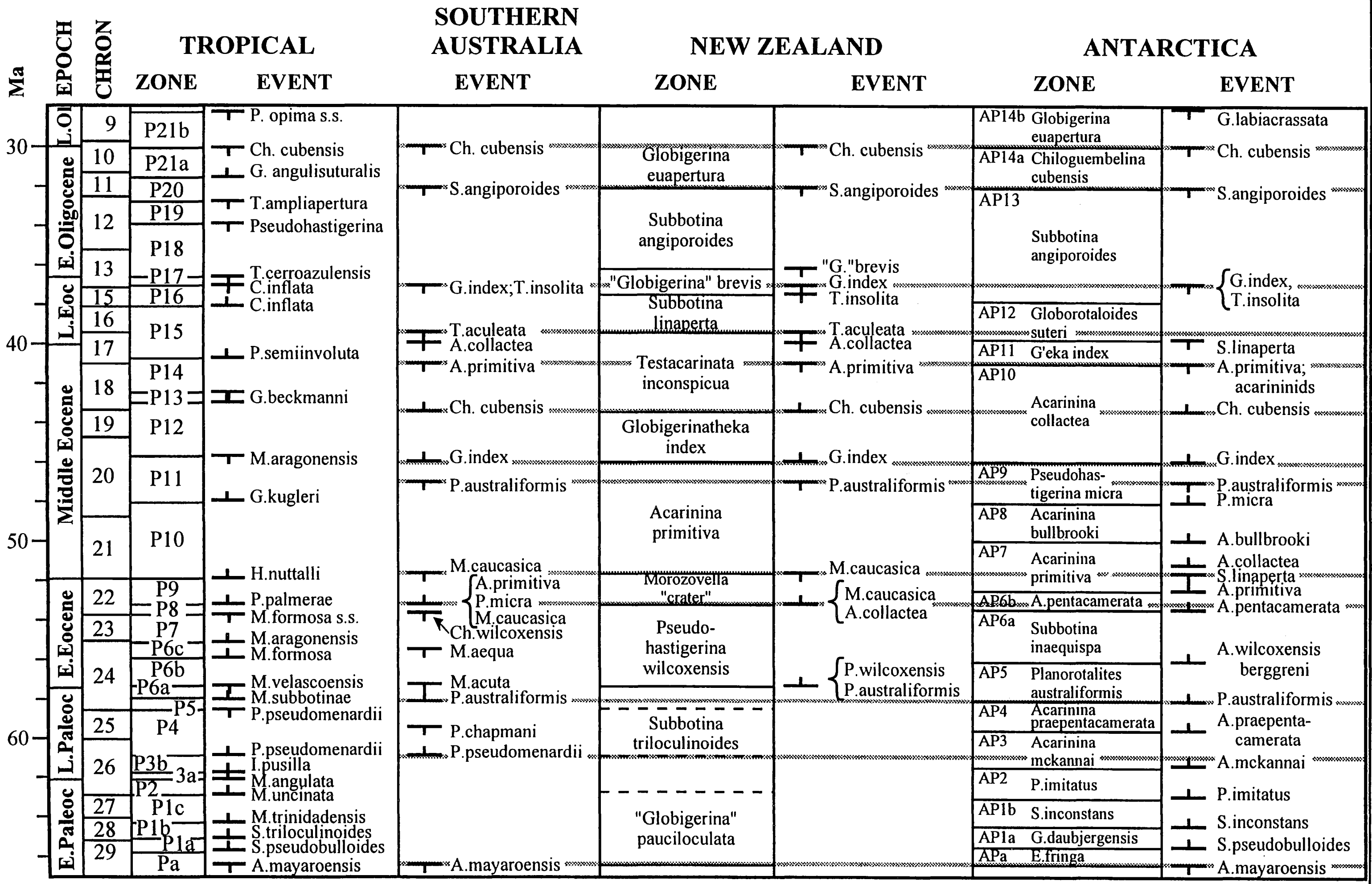


Figure 5. Southern datums: planktonic foraminiferal events in the austral Paleogene. Foggy lines emphasize homotaxial succession. At third-order scales, there is no significant diachronism, such as might be imagined in response to global cooling and the retreat of provincial ocean belts towards the equator. From various sources; Antarctic AP zones from Stott and Kennett (1990).

1.3 PROPOSAL 367 AND THE SEA LEVEL WORKING GROUP REPORT

The scientific objectives of Proposal 367, as outlined in AGSO Record 1994/62 and amplified here, are in accord with the strategies described in the Sea Level Working Group Report (JOIDES Journal 18/3, 1992). Although Proposal 367-Rev2 (Feary et al., 1994) contained an extensive description of the sea-level objectives of the proposal, we did not specifically address the Sea Level Working Group Report (SLWGR) recommendations; we take the opportunity to do so here. In addition, the specific objectives at each of the proposed drill sites, including sea-level-related objectives, are described in Section 4 below.

Proposal 367 seeks to directly address two of the fundamental scientific objectives outlined in the SLWGR, and has the potential to contribute to the third objective. Specifically, we propose sites with objectives to "*date sea-level-related stratigraphic events*" (targeting sequence boundaries marking major Cenozoic sea-level events at <u>all</u> sites), and to "*establish stratigraphic response to sea-level oscillations*" (particularly with sequences to be cored at Sites GAB-03A to GAB-04A and GAB-7A to GAB-09A). This proposal, together with the eastern New Zealand Neogene Proposal 441, were specifically identified in the SLWGR as potentially providing tests of the degree of synchrony of sea-level-related stratigraphic events. We are hopeful that comparisons between the sequences to be cored at the shelf/slope sites and the deep-water paleoceanographic sites will also contribute to the third SLWGR objective; to "*estimate magnitudes and rates of sea-level change through time*". However, because of the 'pioneering' aspect of this proposal, we are unable to be completely confident that this particular objective will be achieved in a significant manner.

This proposal seeks to drill three of the four target intervals identified in the SLWGR; the late Miocene-Recent, late Oligocene-middle Miocene, and the latest Paleocene-middle Eocene. We suggest that the proposed transect from the Eucla Shelf to the middle continental rise will provide an invaluable basis for correlating and comparing the effect of sea-level variations within these target intervals in different oceanographic situations.

The following factors demonstrate the degree to which this proposed drilling transect conforms to the strategies outlined in the SLWGR:

• the existence of a regional framework of mapped sequences and sequence boundaries, based on an extensive tied grid of excellent 2D multichannel seismic data (partially presented in Feary et al., 1994 and Feary and James, 1995). At present, we propose a eustatic origin for the stratal geometry of several of the Cenozoic sequences (Feary and James, ms in prep); testing these suggestions by drilling will undoubtedly provide an understanding of the relationship between stratal geometry, sedimentary facies, and sea-level fluctuations.

• an excellent potential for constraining the age of sequence boundaries, and assessing the synchrony with well-dated sequence boundaries elsewhere, as demonstrated in the description of the range of biostratigraphic datums available (presented in Section 1.2 above).

• the absence of any significant dilution by siliciclastic sediment in the western Great Australian Bight from the Eocene onwards makes this transect the ideal place to establish the stratigraphic response to sea-level oscillations of the cool-water carbonate end-member. This is particularly important as most sea-level studies have concentrated on comparing siliciclastic and warm-water carbonates; it appears likely that cool-water carbonates, so important in the geologic record but so little understood (mostly because of the absence of the type of research proposed here), will constitute a third end-member (probably closer to the siliciclastic situation than the warm-water carbonate situation!).

• the calcitic nature of cool-water carbonate sequences, described in Section 1.1 above, potentially provide an opportunity for obtaining detailed $\delta^{18}O$ records, without the pervasive diagenetic alteration characteristic of originally aragonitic carbonates, within upper slope and continental rise sections that are unlikely to be significantly affected by sediment gravity flow deposits.

The proposed Great Australian Bight transect will certainly not provide answers to all the questions addressed in the SLWGR; rather, we perceive the scientific objectives outlined in this proposal as contributing one of the important elements, namely, the stratigraphic response of cool-water carbonates in a passive margin setting to sea-level oscillations.

2. TECHNICAL AND SAFETY CONSIDERATIONS

Comments from panel reviews indicate that it is necessary to specifically address a range of technical and safety issues, in order to demonstrate that drilling the Great Australian Bight transect can be accomplished efficiently, and without greater risk than is ordinarily present during drilling operations on the *Joides Resolution*. Nevertheless, we understand that recent operational problems (in 270 m water depth!) have caused SEDCO to revise the minimum drilling depth from 50 to 75 m, and that accordingly, we must take into account the likelihood that the three sites in 50-55 m water depth may be undrillable by the *Joides Resolution*. We have retained these shallow sites in this drilling proposal revision, firstly, because we feel that they are an integral component of the scientific objectives; and secondly, because panel confirmation of the importance of these sites will assist with our efforts to obtain access to an alternative drilling platform.

2.1 SITE LOCATION

The proposed drill sites form a shelf to basin transect, extending from mid-shelf sites at 50-55 m, through shelf edge and upper slope terrace sites at 196-1039 m, to middle and upper continental rise sites at 3860-4465 m (Figs 6-7). The specific objectives and anticipated stratigraphy at each site are presented in Section 4.

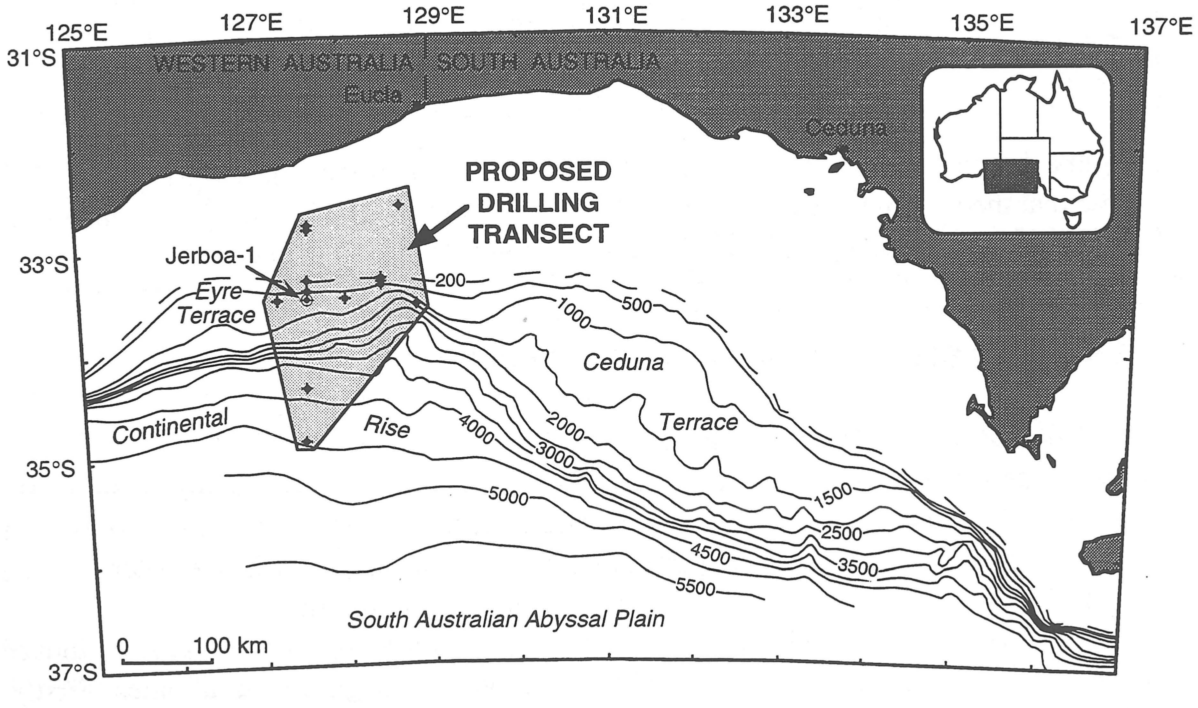


Figure 6. Map showing bathymetry of the Great Australian Bight, together with the location of the proposed ODP drilling transect.

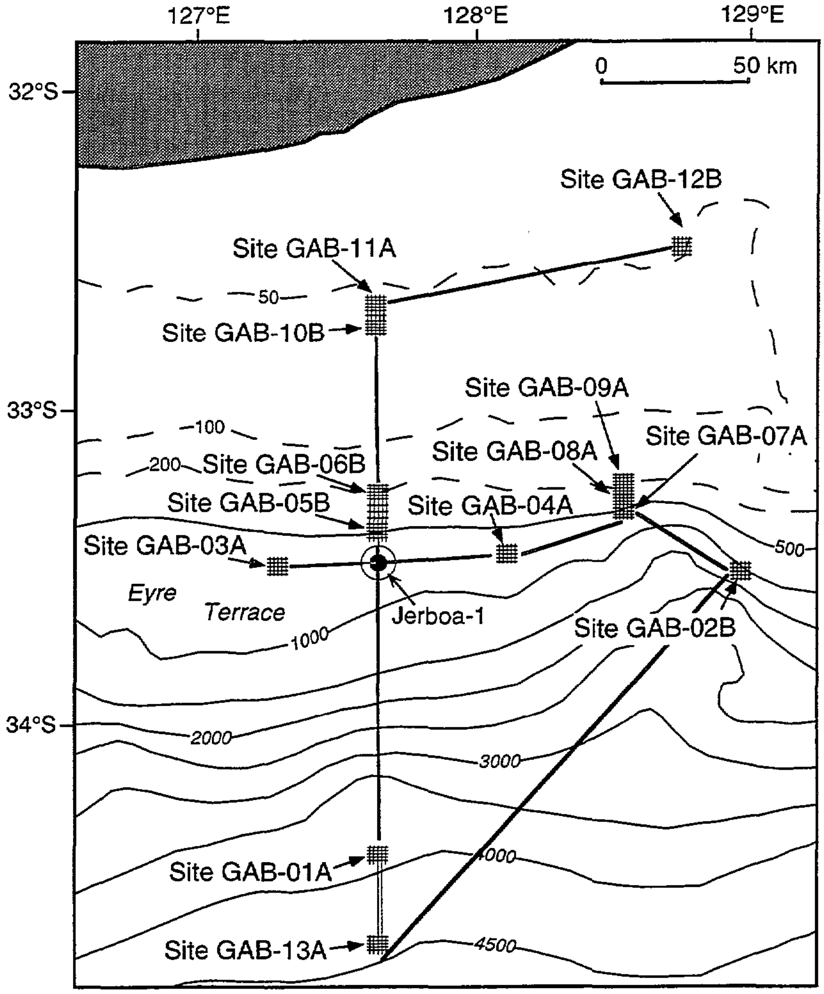


Figure 7. Location of the proposed ODP drill sites in the western Great Australian Bight. Note that the shallow sites (GAB-10B, GAB-11A, and GAB-12B) are under threat from the proposed deepening of *Joides Resolution* minimum operating depth.

2.2 DRILLING STRATEGY AND SAFETY ISSUES

2.2.1 Shallow Water Issues

Potential operational and safety issues arising from shallow water drilling relate to (i) gas escape with the potential to endanger the vessel; (ii) the difficulty in holding station in DP mode and drilling difficulties arising from high seas and swells; and (iii) the potential for poor recovery from shallow water sediments. These are addressed in turn:

(i) several factors indicate that the risk of encountering shallow gas, or indeed, of intersecting intervals with even traces of hydrocarbons, is negligible at all sites. Firstly, the exploration holes drilled onshore (Gambanga-1 and Eyre-1) and offshore (Jerboa-1) uniformly reported nil indications of hydrocarbons. As the well completion reports for these holes were presented to shareholders, any slight hint of hydrocarbons would have been emphasised (if only to justify the geologist's choice of drill site!). Secondly, unpublished, 1973-vintage, poor-to moderate-quality AGSO sparker sections across the Eyre Shelf show a 'sawtooth' pattern at the water bottom, representing the eroded edges of very gently offshore-dipping bedding, and indicating that much of the interval immediately below the seabed is open to the sediment surface. And thirdly, the shallow sites are located in the middle of a very wide area (≈20000 km^2) of shallow, flat-lying, planated cratonic basement composed of Precambrian granitic gneiss and granodiorite. The sedimentary section overlying this planated basement surface is only 500-600 m thick, and the top basement reflector is particularly clear (see interpreted and uninterpreted seismic data for sites GAB-10B, GAB-11A, and GAB-12B presented in Section 4, and also Figs 11 and 19 in the previous proposal revision; AGSO Record 1994/62).

(ii) During meetings with Mr Gene Pollard (Drilling Superintendent) and other operations personnel at ODP-TAMU in September, 1995, a strategy was developed to ensure that operations in shallow water could be undertaken with maximum likelihood of success. We recognise that calm conditions are crucial for shallow water drilling, and recommend that any drilling leg be scheduled during the late summer months (mid-December to late March; see Section 2.3.1 below). In addition, the proximity of the shelf edge and upper slope sites to the shallow sites (5-6 hours transit), together with the reasonably accurate marine weather forecasts available in this area, means that these shallow sites can be drilled during calm weather windows. During these times, we would anticipate that heave at the derrick would be only 1-1.5 m.

(iii) Firstly, we emphasise that the anticipated lithologies in all but a portion of site GAB-11A are expected to be 'chalky' carbonates in which moderate to high recovery rates are likely, with only some of the section at GAB-11A expected to be the lithified, warm-water carbonates that have proved difficult to recover on earlier legs (eg. Legs 133 and 144). A second component of this shallow drilling strategy is the recommendation that the three shallow sites be initially drilled with RCB and then logged, so that a combination of APC, XCB, and MDCB can then be precisely deployed to penetrate particular layers with variable hardness.

2.2.2 Drilling Time Estimates

As part of the meetings with Mr Gene Pollard in September, careful (and conservative) calculations of estimated drilling times showed that original site objectives exceeded a drilling leg by 6-8 days. In view of the uncertainty concerning minimum water depth allowable for drilling, we now present two possible combinations of sites to constitute a drilling leg, with alternate sites identified as appropriate. Some fine-tuning of these combinations will be possible later, particularly as full logging suites at every site are included in these calculations at present.

Site combination including shallow sites:

SITE	MIN. TIME (days)	MAX. TIME (days)	WD (m)	PENETR. (m)	DRILL TYPE
GAB-01A	5.5	6.5	3860	740	APC(3)/XCB/RCB
GAB-02B	7.5	9.5	1039	1575	APC(3)/XCB/RCB
GAB-03A	3	4	680	545	APC(2)/XCB
GAB-04A	5.5	7	750	680	APC(2)/XCB
GAB-05B	5.5	6.5	482	620	APC(2)/XCB/RCB
GAB-06B	5.5	6.5	214	725	APC(2)/XCB/RCB
GAB-07A	2.5	3	469	615	APC(2)/XCB
GAB-08A	alt	alt	315	-	APC(2)/XCB
GAB-09A	2.5	3	196	630	APC(2)/XCB
GAB-10B	3.5	4	52	430	RCB/APC(2)/XCB/MDCB
GAB-11A	4	5	51	475	RCB/APC/XCB/MDCB
GAB-12B	4	5	50	435	RCB/APC/XCB/MDCB
GAB-13A	alt	alt	4465	-	APC(3)/XCB/RCB
TOTAL	49	60		total	

Site combinations excluding shallow sites, and including deep site GAB-13A:

SITE	MIN. TIME (days)	MAX. TIME (days)	WD (m)	PENETR. (m)	DRILL TYPE
GAB-01A	5.5	6.5	3860	740	APC(3)/XCB/RCB
GAB-02B	7.5	9.5	1039	1575	APC(3)/XCB/RCB
GAB-03A	3	4	680	545	APC(2)/XCB
GAB-04A	5.5	7	750	680	APC(2)/XCB
GAB-05B	5.5	6.5	482	620	APC(2)/XCB/RCB
GAB-06B	5.5	6.5	214	725	APC(2)/XCB/RCB
GAB-07A	2.5	3	469	615	APC(2)/XCB
GAB-08A	2.5	3	315	670	APC(2)/XCB
GAB-09A	2.5	3	196	630	APC(2)/XCB
GAB-10B	-	-	52	-	RCB/APC(2)/XCB/MDCB
GAB-11A	-	-	51	-	RCB/APC/XCB/MDCB
GAB-12B	-	-	50	-	RCB/APC/XCB/MDCB
GAB-13A	8.5	10.5	4465		APC(3)/XCB/RCB
TOTAL	48.5	59.5		total	

2.3 WEATHER CONDITIONS AND WATER CURRENTS

As required in the PPSP Guidelines and requested by panel reviews, we present a statement concerning weather and water conditions in the western Great Australian Bight. We suggest that these data demonstrate that the preferred drilling window is from late November to early April, with the optimum period being January-March.

2.3.1 Weather Conditions in the western Great Australian Bight

Weather patterns in the Great Australian Bight are controlled by the position of the band of mid-latitude high pressure systems that pass over Australia from west to east. During the summer months (November to February), these high pressure cells pass directly over southern Australia and the Great Australian Bight, and often a high pressure cell lingers directly over the Bight area. As a result, there are lengthy periods of calm weather in the Great Australian Bight, with wind flow dominantly from the southeast in the mornings and from the continent during the afternoon and evening. Farther south, weak cold fronts between the high pressure cells bring moderate southwesterly winds. During the winter months (May to August), the band of high pressure systems is displaced to the north, and the Great Australian Bight is more influenced by the strong mid-high latitude westerly wind flow, containing embedded strong cold fronts. Wind strength (Fig. 8) and direction (Fig. 9) patterns at Eucla, at the head of the Great Australian Bight, reflect this shift; winds in the summer months have fewer strong winds and gales, and show greater directional variability, compared with the winter months when the area is strongly dominated by southeasterly winds. A wind 'surge' effect ahead of approaching high pressure systems frequently produces higher winds during the early summer, so that the late summer (January to April) is the period with highest probability of calm conditions.

Temperature patterns (Fig. 10) show that Eucla experiences coolest temperatures in July-August, and warmest temperatures in January-February. Rainfall is generally higher in April-September (although only 20-30 mm), and very low between October-March.

2.3.2 Water Currents in the western Great Australian Bight

Water conditions in the Great Australian Bight are dependant on both local and distant effects. Local winds in the Great Australian Bight and southern Australia area, as described above, produce wave activity that shows a marked fluctuation between the calmer late summer months and the rough winter months. In addition, wave activity generated from far to the south, by storms in the mid-high latitude westerly wind belt (the 'roaring 40's' and 'furious 50's'), impact on the Great Australian Bight. This is particularly the case in winter, when the westerly wind belt is displaced to the north, but is less important in summer. Data from the TOPEX/POSEIDON satellite provides global images of wave height and wind speed every 3.3 days; typical images from February/March 1993 and July/ August 1993 illustrate the marked differences in wave activity to be expected in late summer and mid-winter, respectively (see Fig. 11).

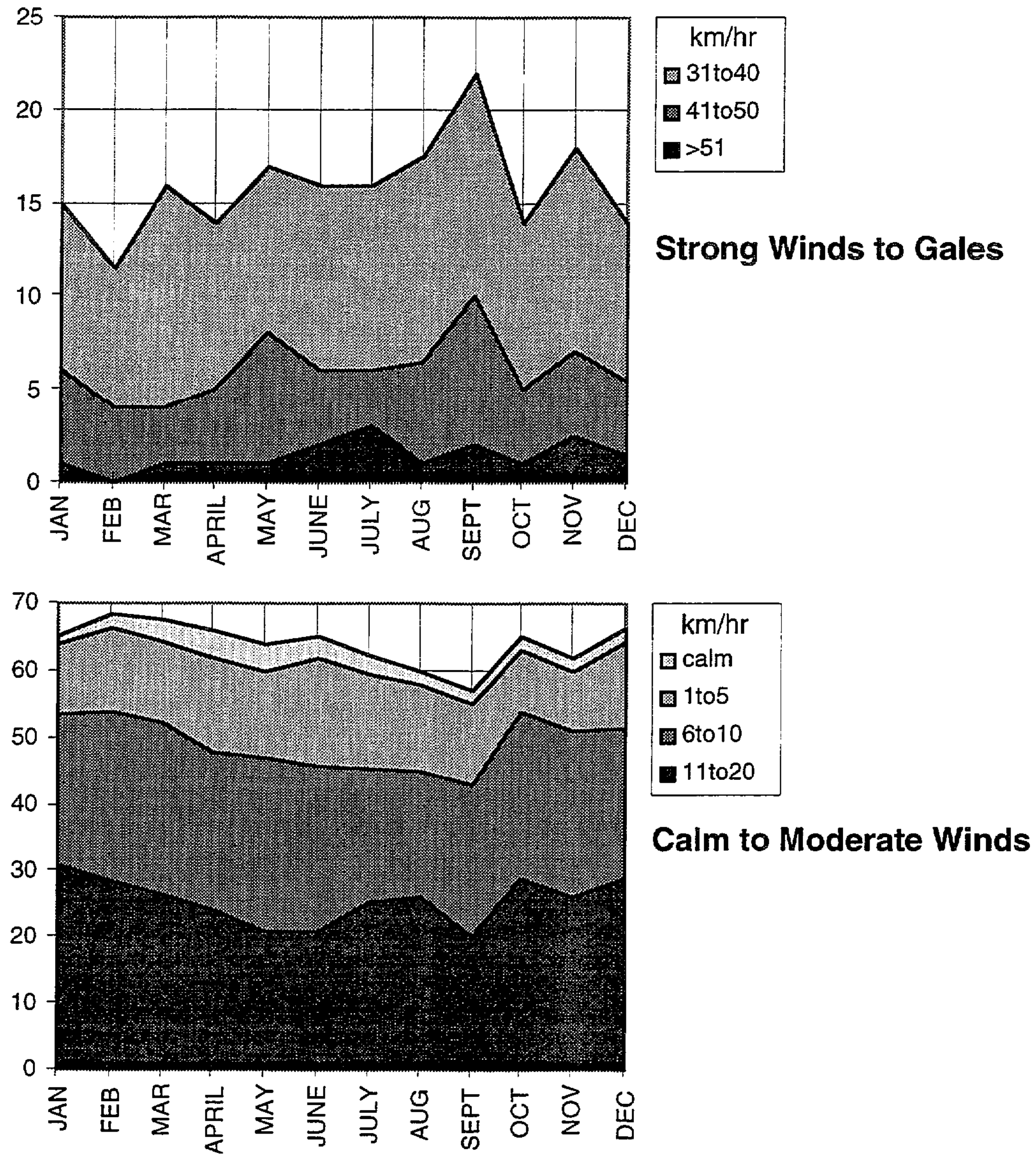


Figure 8. Wind strength data for Eucla, at the head of the Great Australian Bight (see Fig. 1), clearly showing calmer conditions during late summer (January-March). Data displayed are 35-year average morning (0900 hrs) wind speeds; afternoon data are distorted by offshore winds that have little effect farther out to sea, at the proposed drill sites.

Current flow in the Great Australian Bight is limited to activity of the Leeuwin Current, a year-round flow of warm, low salinity water southwards along the coast of Western Australia. This flow is strongest in winter, when it is able to flow around Cape Leeuwin and extend eastwards into the Great Australian Bight. However, although Leeuwin Current flow can be quite strong off the western margin of Australia (up to 1.5 m/sec at Cape Leeuwin), by the time it reaches the central Great Australian Bight it has weakened considerably. It has negligible effect in the central Great Australian Bight during summer, and even in winter has only minor effect.

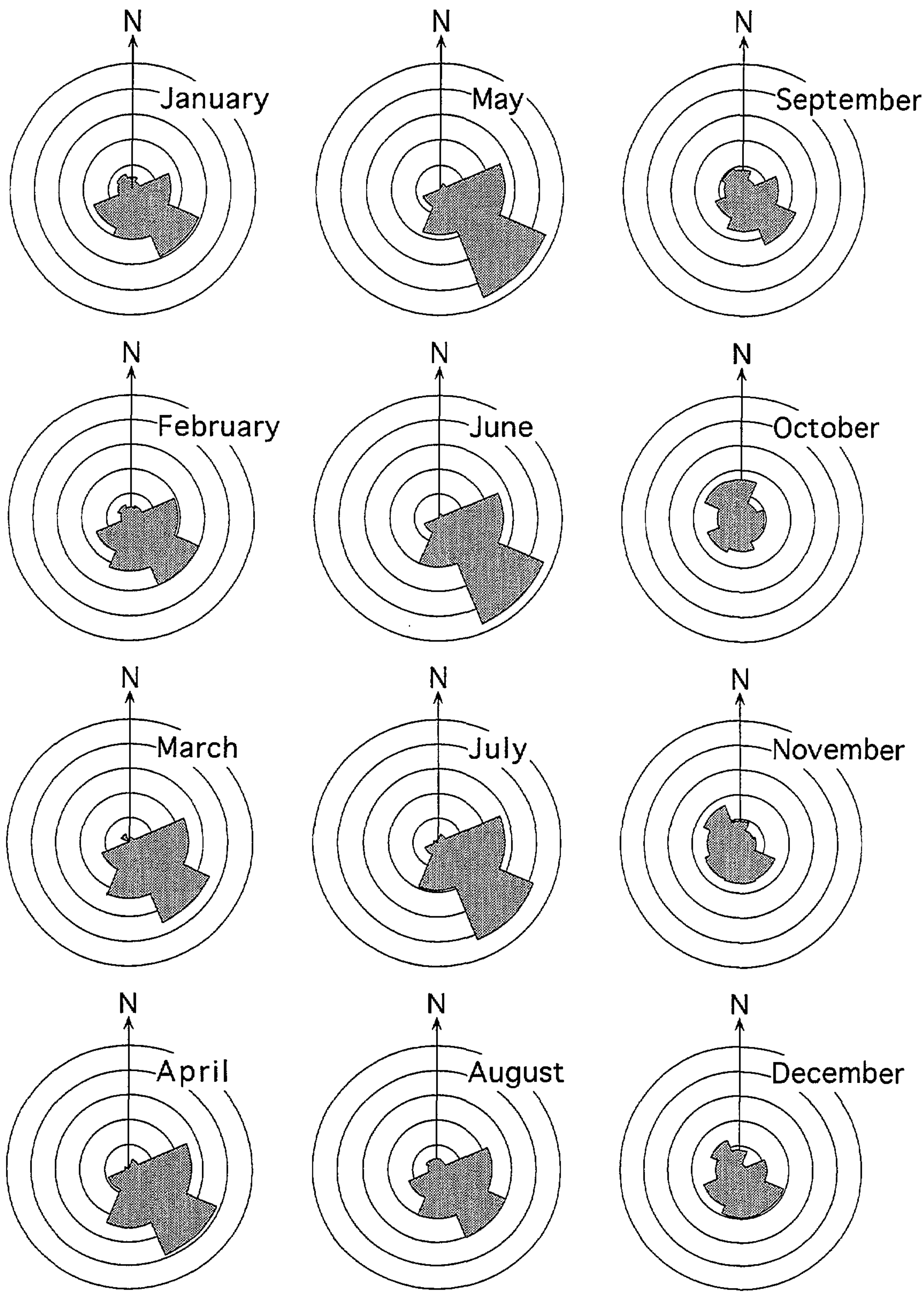


Figure 9. Wind direction rose diagrams for Eucla, at the head of the Great Australian Bight (see Fig. 1). Data displayed are 35-year average morning (0900 hrs) wind directions for each month; afternoon data are distorted by offshore winds that have little effect farther out to sea, at the proposed drill sites. Each concentric circle represents 10% of readings.

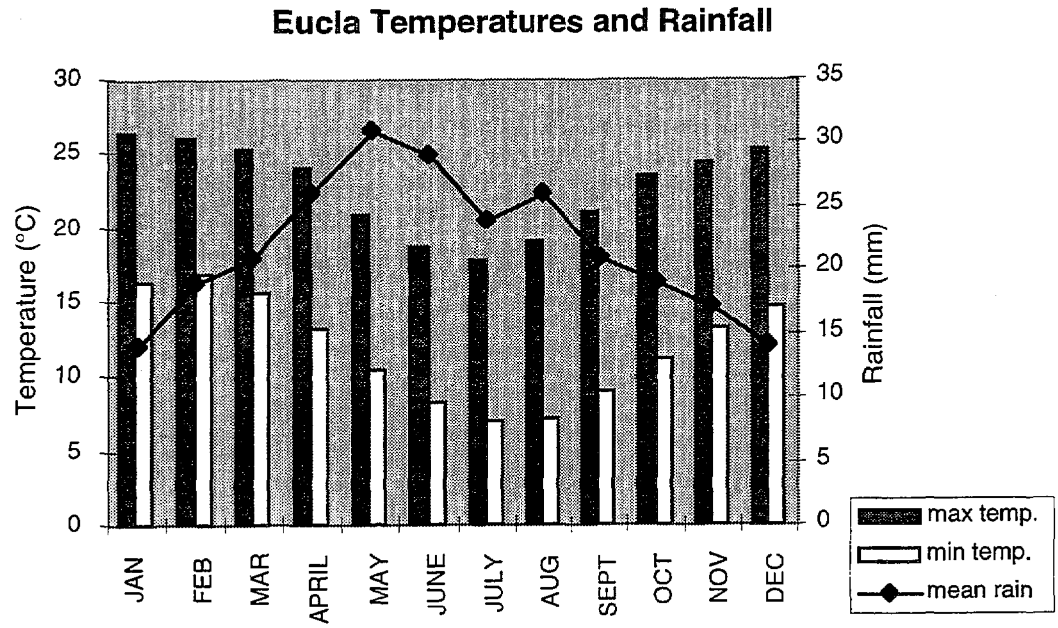


Figure 10. Temperature and rainfall data for Eucla, at the head of the Great Australian Bight (see Fig. 1). Data are 25-year (temperature) and 104-year (rainfall) averages.

2.3.3 Environmental Factors

The Great Australian Bight is a breeding area for Southern Right Whales. The Australian Nature Conservation Agency (ANCA), the Federal government agency responsible for cetacean monitoring and conservation, has advised that the Southern Right Whale breeding season extends from mid-May to mid-October, and that we would be unlikely to gain approval for seismic work in this area from early May to late October. We do not anticipate that any such limitation would apply to drilling; nevertheless, this further reinforces the recommendation that drilling be undertaken during the Australian summer months.

2.4 SITE SURVEYS

A site survey cruise, using the AGSO research vessel *Rig Seismic*, is presently scheduled for the period 21st January to 8th February, 1996. During this time, detailed grids (Fig. 12) of seismic tracks with 0.5 nm spacing will be recorded at each proposed site, to obtain a three-dimensional image of reflector geometry (site survey parameters are presented in more detail in Feary, 1995 - AGSO Record 1995/67). Site surveys will be shot using twin Seismic Systems Inc GI guns operating in bubble-suppression mode, with a 160-channel streamer configured in 6.25 m groups. This will provide 3 seconds of 40-fold data at 3.125 cdp spacing. Maximum navigation accuracy will be provided by dual differential GPS systems, with additional dual GPS units on the tailbuoy. Magnetometer, gravity meter, echosounder, and sub-bottom profiler data will also be continuously collected. Equipment problems have resulted in the gravity coring, vibra-coring, and seafloor photography components being deferred until later in 1996.

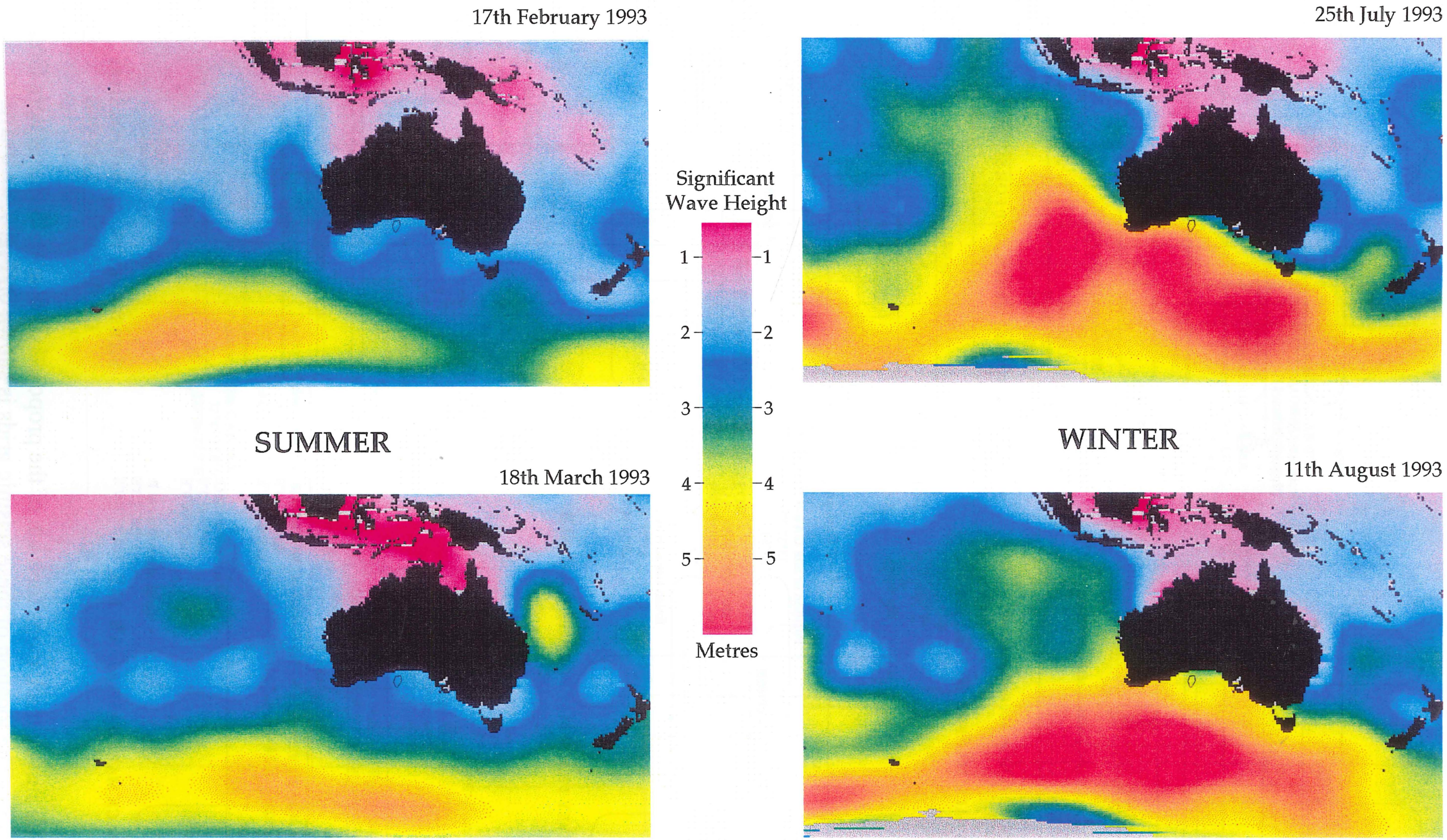
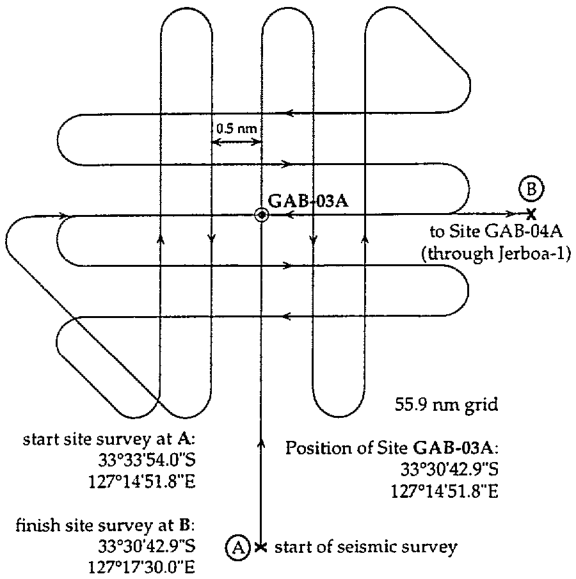
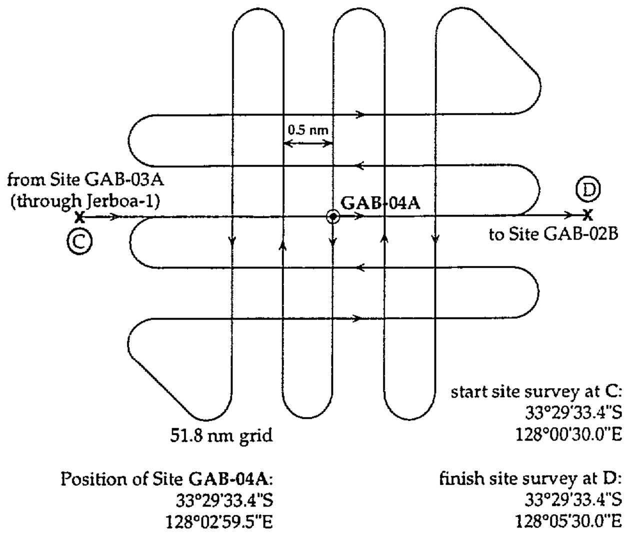


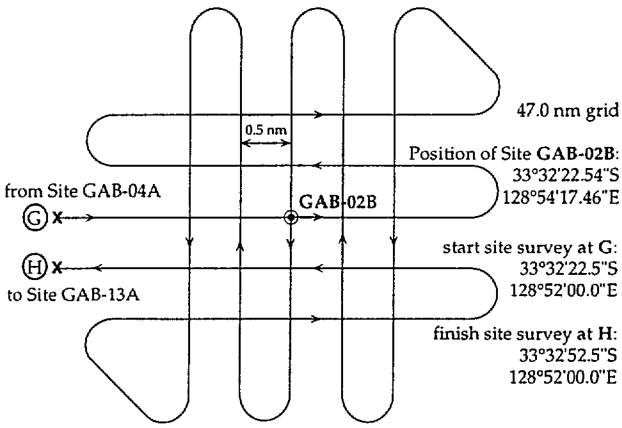
Figure 11. Typical wave height images generated from TOPEX/POSEIDON satellite data. Note the increased wave heights along Australia's southern margin during the winter months (July-September), compared with the lower wave heights during the mid-late summer (January-March).



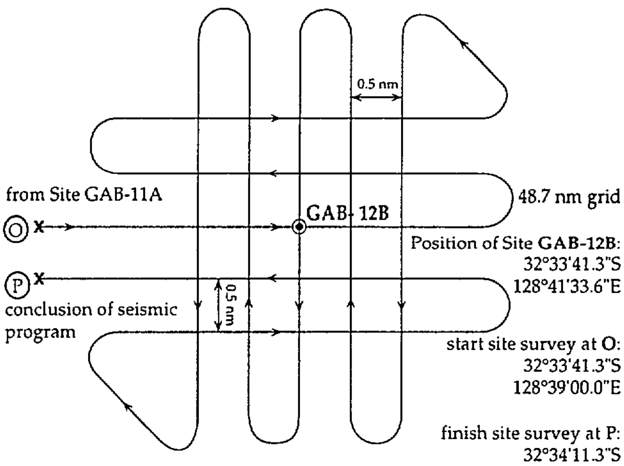
SITE SURVEY TRACK MAP FOR SITE **GAB-03A**



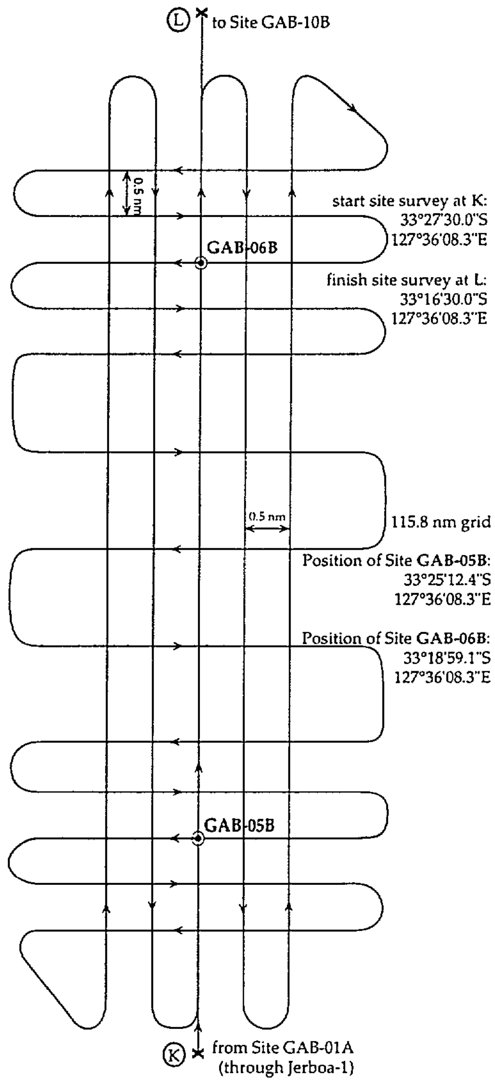
SITE SURVEY TRACK MAP FOR SITE **GAB-04A**



SITE SURVEY TRACK MAP FOR SITE **GAB-02B**

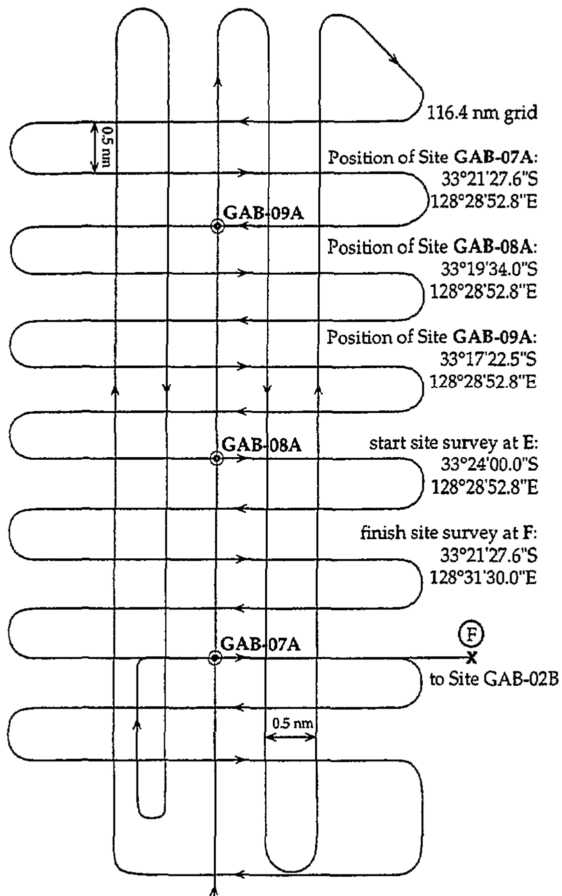


SITE SURVEY TRACK MAP FOR SITE **GAB-12B**

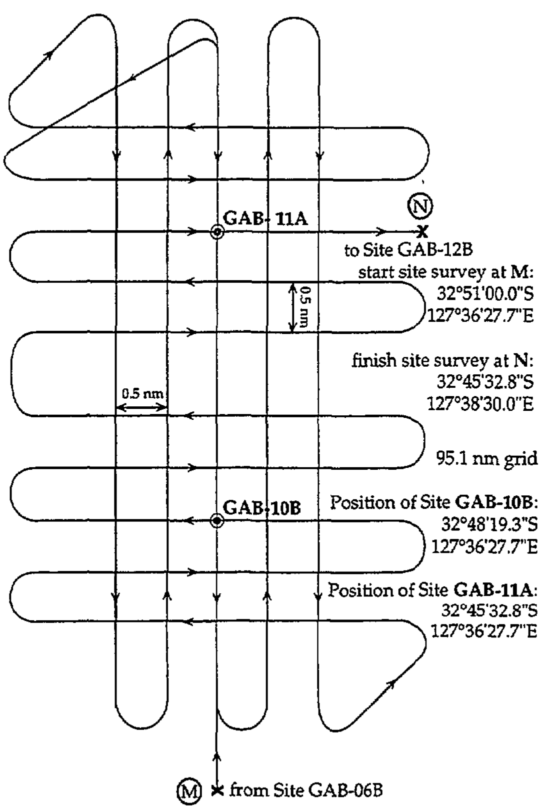


SITE SURVEY TRACK MAP FOR SITES **GAB-05B AND GAB-06B**

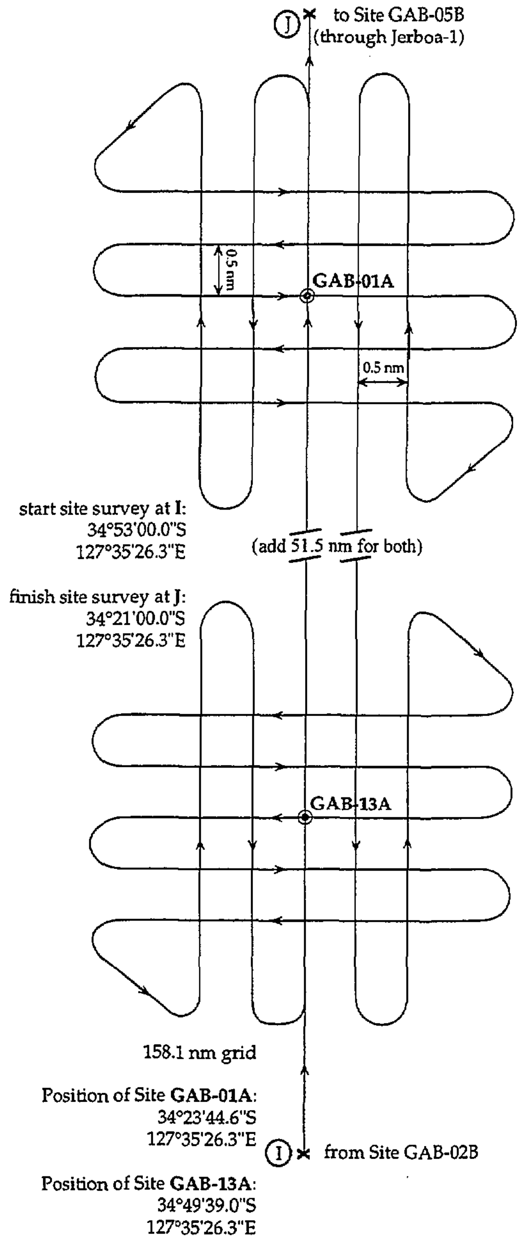
Figure 12. Site survey track maps for each of the proposed ODP sites in the western Great Australian Bight. The location of these seismic grids is shown on Fig. 7.



SITE SURVEY TRACK MAP FOR SITES GAB-07A TO GAB-09A



SITE SURVEY TRACK MAP FOR SITES GAB-10B AND GAB-11A



(these sites may be moved slightly on the basis of the stratigraphy observed on the long initial line through both sites)

SITE SURVEY TRACK MAP FOR SITES GAB-01A AND GAB-13A

3. RESPONSES TO SPRING 1995 PANEL COMMENTS

Responses from OHP and SGPP during the Spring 1995 review process, together with SSP comments from their April and July 1995 meetings, have contributed both to modified site locations and to improvements in the description of scientific objectives. In addition, we welcome the opportunity to clarify several aspects of our drilling proposal by addressing specific comments from these panels:

3.1 OCEAN HISTORY PANEL COMMENTS

OHP Spring 1995 Ratings: A1, B1.1, B2.1, C1, D1, E8, F2. Ranked 8th.

- noted that a detailed statement is required to address safety issues arising from the location of sites in less than 200 m water depth. The site survey cruise proposal (AGSO Record 1995/67) was based on adherence to SWGHS guidelines for the four sites in less than 200 m water depth. However, in view of the recent uncertainty concerning the minimum operating depth limit for the *Joides Resolution*, and the considerable costs involved with collecting site survey data conforming to SWGHS guidelines, we now plan to collect only a basic 0.5 nm grid over all sites in January-February 1996 (see Section 2.4). If the 50 m depth limit is retained, data to be collected during the early 1996 site survey cruise will form the basis for determining precise parameters for higher density tracklines over the shallow sites, to be collected at some later date.

- noted that the optimum weather window should be specified for this open southern shelf setting. Sections on weather conditions and currents in the western Great Australian Bight are included in the site survey cruise proposal (AGSO Record 1995/67), and are reproduced here (see Section 2.3).

- recommended that one or more of the oceanic sites be shifted and deepened to penetrate Paleocene and perhaps late Cretaceous sections with triple HPC. We have deepened sites GAB-03A and GAB-04A to intersect significant Paleocene/late Cretaceous intervals, and deepened sites GAB-01A and GAB-02B to recover the upper part of the Paleocene or late Cretaceous section. We have also reinstated site GAB-13A, as an alternate for the shallow water sites now at risk, to recover a Cretaceous and condensed Cenozoic section recording the history of CCD fluctuations and a partial history of deep water mass variations during evolution of the Southern Ocean. However, we anticipate that most of the deeper parts of these sites will be too deep for APC operations, and that XCB or RCB drilling will be required. We will be requesting PPSP clearance for drilling a reasonable distance beyond the primary target at all sites, to retain the flexibility to deepen one or more sites if sediment age and recovery rates indicate that a significantly improved record can be recovered below present TD. The present site GAB-01A is located on the extreme margin of the JNOC-90 seismic grid used for site location, and GAB-13A is located beyond this grid; we are hopeful that the extended seismic grid acquired during site surveys will allow identification of even better sites.

- *noted that site GAB-5A is located so close to an inferred magmatic intrusion that there is a possibility of sediment alteration by magmatic fluids; the site would be better moved upslope or along slope to avoid this problem*. We have identified new sites GAB-05B and GAB-06B on line JA90-23, where no volcanic mounds are present. This has the added advantage that the new site GAB-06B intersects an excellent distal section of seismic sequence 3, as requested by both SGPP and SSP.

3.2 SEDIMENTARY AND GEOCHEMICAL PROCESSES PANEL COMMENTS

SGPP Spring 1995 Ratings: A1, B1.2, B2.1, C1, D1, D5 (PPSP), E-no obvious deficiencies, F2. Ranked 7th.

- *noted that we should communicate with ANTOSTRAT and other groups interested in the Antarctic margin, and should participate in any forthcoming workshops.* Material has been despatched to Dr Kristoffersen in Bergen, with a request for continued interaction. No reply has been received.

- *noted that seismic sequences 3 and 5 are neglected.* Site GAB-06B has been located to intersect an excellent distal section through Sequence 3, and GAB-10B has been re-sited to intersect a more complete section through Sequence 5. We consider that both these sequences are now able to be well characterised by drilling.

- *noted that the proposal should make reference to strategies suggested in the Sea-Level Working Group Report for site justification.* This is addressed in the Section 1.3 above.

- *noted that the fluid flow objectives are inadequately discussed in the proposal, and recommended that we should consider adding a hydrogeologist to the team*. Dr Peter Smart, a hydrogeologist at Bristol University, has agreed to be the hydrogeologist co-proponent for this proposal. A substantially upgraded statement of fluid flow objectives is included in this revised proposal (Section 1.1).

- *noted concern about the problems of recovery and the ability of the* Joides Resolution *to drill in only 50 m water depth, and asked whether there was any possibility of drilling the shallow end of the transect with a jack-up rig and diamond coring (as used in the Bahamas).* Discussions of the problems of drilling in shallow water depths with drilling personnel at ODP-TAMU indicate that, although technically difficult, it is possible to design an appropriate drilling strategy to maximise the chance of successful recovery. One important element is the requirement for the leg to be at the optimum time of the year (December-April), and to be designed with enough flexibility to take advantage of calm weather windows as they eventuate. If the minimum drilling depth is changed to 75 m so that our three shallow sites are undrillable from the *Joides Resolution*, then we will have to investigate the option of obtaining access to a jack-up rig; we anticipate that obtaining funding for this option will be difficult.

- *asked a number of questions:*

• *what level of recovery can be expected in this type of carbonate? (Some panel members suggested that if the carbonates are chalk-matrix bryozoan limestones, recovery problems may be minimised)*. We emphasise that we do anticipate bryozoan limestones with fine-grained, chalky matrix at most sites, and that only at site GAB-11A are we likely to drill a significant interval of warm-water reefal carbonates of the type that have had poor recoveries on earlier legs (eg, Legs 133 and 144).

• *how much use of the MDCB is anticipated*? After discussions with ODP-TAMU drilling personnel, we anticipate some MDCB use at the shallow sites GAB-10B, GAB-11A, and GAB-12B. At each of these sites, an initial RCB hole will provide sufficient information for very careful MDCB deployment for short intervals (see Section 2.2).

• *how will uncontaminated fluid samples be retrieved from the friable carbonates*? We recognise that this is a significant problem, that will require further careful discussion with ODP technical personal prior to drilling.

• *should the areas on top and outside the mounds be avoided because these sediments might be more winnowed, friable, and difficult to recover*? We infer that most of the carbonate mounds identified on seismic sections were deposited in low energy conditions, and accordingly, doubt that the sediments would have been subject to extensive winnowing.

• *what dating schemes will be most useful in these carbonates?* This question is addressed fully in Section 1.2.

• *can age correlations be made to the Antarctic margin?* This is also covered in Section 1.2, and particularly addressed in Fig. 4.

3.3 SITE SURVEY PANEL COMMENTS

- *noted that only a small amount of data had been submitted prior to its Spring 1995 meeting, and noted that the proposed sites would require re-evaluation once the comments made at the meeting were acted upon, and further data submitted.* The main body of data will be submitted once the site survey cruise is completed, and the data has been processed; an interim submission of the data presently available was made in October 1995, prior to the early November SSP meeting. We recognise the need for speedy processing of the January-February 1996 site survey seismic data, and are working to ensure that these data receive high priority.

- *noted that original sites GAB-10A, GAB-11A, and GAB-12A were too shallow for Joides Resolution*. Sites in water depths shallower than 50 m have been moved to depths of 50 m or greater. Discussions with Mr Gene Pollard, Operations Superintendent, at ODP-TAMU in September 1995 resulted in the development of a drilling strategy for these shallow sites, presented in Section 2.2.

- *noted that sites less than 200 m water depth would require site surveys conforming to the SWGHS guidelines*. To repeat the reply presented in 3.1 above: The site survey cruise proposal (AGSO Record 1995/67) was based on adherence to SWGHS guidelines for the four sites in less than 200 m water depth. However, in view of the recent uncertainty concerning the minimum operating depth limit for the *Joides Resolution*, and the considerable costs involved with collecting site survey data conforming to SWGHS guidelines, we now plan to collect only a basic 0.5 nm grid over all sites in January-February 1996 (see Section 2.4). If the 50 m depth limit is retained, data to be collected during the early 1996 site survey cruise will form the basis for determining precise parameters for higher density tracklines over the shallow sites, to be collected at some later date.

- *required improved seismic velocity information, as there was concern that carbonate seismic velocities had been underestimated, with consequent underestimation of drilling depth. Velocity analyses from reflection and refraction seismic and well log data were required to substantiate velocities used, and the panel noted that a depth-converted composite section or a regional geological cross-section in depth might better represent drilling sites.* NMO velocities from existing reflection seismic data have been used to derive the drilling depths listed on the Site Summary Forms, and T-D plots for each site are provided in Section 4 below. Although NMO velocities are imperfect for time-depth conversion, these stacking velocities should provide depth indications within approximately 20-40 m for most sites. A composite depth-converted section will be possible once the site survey seismic tie-lines are collected.

- *noted that water current information is required for shallow water drilling.* Sections on weather conditions and currents in the western Great Australian Bight are included in the site survey cruise proposal (AGSO Record 1995/67), and are reproduced here in Section 2.3.

- *noted that a considerable body of data is required to be submitted to the Data Bank; namely a grid of intersecting deep SCS or MCS lines and 3.5 kHz data, with side-scan sonar and detailed bathymetry, gravity, and magnetics.* The site survey proposal supplied to SSP and the JOIDES Office in September 1995 (AGSO Record 1995/67) describes the considerable body of data to be collected in early 1996. If the SSP requires more of the existing extensive grid of airgun seismic data collected by JNOC (only the lines with ODP sites were forwarded to the Data Bank in October 1995 - see Appendix 1), we could easily supply such additional data upon request.

- *noted that magnetic data and modelling may discriminate between carbonate and volcanic mounds.* We had hoped to be able to prepare gravity and magnetic maps for the October 1995 Databank submission; however, the recent arrival of the data from Japan has meant that these maps have not yet been completed. Examination of JNOC maps generated as part of their exploration effort show that the small volcanic mounds have minimal magnetic expression (although we hope that further processing of this data may show some evidence of the volcanic trend). We doubt that gravity modelling will have sufficient resolution to identify the small volcanic mounds.

- *noted that it would be possible to intersect more of the mounded facies by moving some sites.* We have moved some sites slightly (GAB-10B, GAB-12B), but we note that it is our objective to recover representative sections through <u>both</u> mounded and non-mounded seismic facies.

- *noted that sites GAB-2A and GAB-5A are too close to volcanic intrusions to be representative* *of the carbonate facies*. As noted above, site GAB-2 has been moved slightly (GAB-02B) away from the volcanics, although with the present seismic data it is not possible to identify a suitable site farther away; we hope that this will be possible once the high-resolution site survey data is acquired. Site GAB-5A has been replaced with GAB-05B, where volcanic mounds are not present.

- *noted that seismic sequences 3 and 5 should be better sampled.* Site GAB-06B has been located to intersect an excellent distal section through Sequence 3, and GAB-10B has been re-sited to intersect a more complete section through Sequence 5.

- *noted that for seismic stratigraphic purposes, it would be better if all sites are located along a single industry line or on a new line*. We agree that this would be the optimum situation; however, the scientific objectives in this proposal are distributed over a wide area covered by the existing data grid, and we see no way of relocating more sites to lie on a single existing line or along any new line. However, we do propose that all sites will be linked by high-resolution MCS data to be collected during the proposed site survey cruise. We also note that 6 of the 13 sites (GAB-01A, GAB-05B, GAB-06B, GAB-10B, GAB-11A, and GAB-13A) are at present located on a single line, ranging from shallow mid-shelf (50 m) to mid continental rise (4465 m) depths.

4. PROPOSED DRILL SITES IN THE GREAT AUSTRALIAN BIGHT

The following descriptions of the proposed drill sites in the western Great Australian Bight (Fig. 13) include a summary of the scientific objectives for each group of sites; an ODP Site Summary Form for each site; and portions of uninterpreted and interpreted multichannel seismic lines showing the seismic sequences intersected by each proposed drillhole. A summary of the portions of each seismic sequence sampled at each site is shown in Fig. 14.

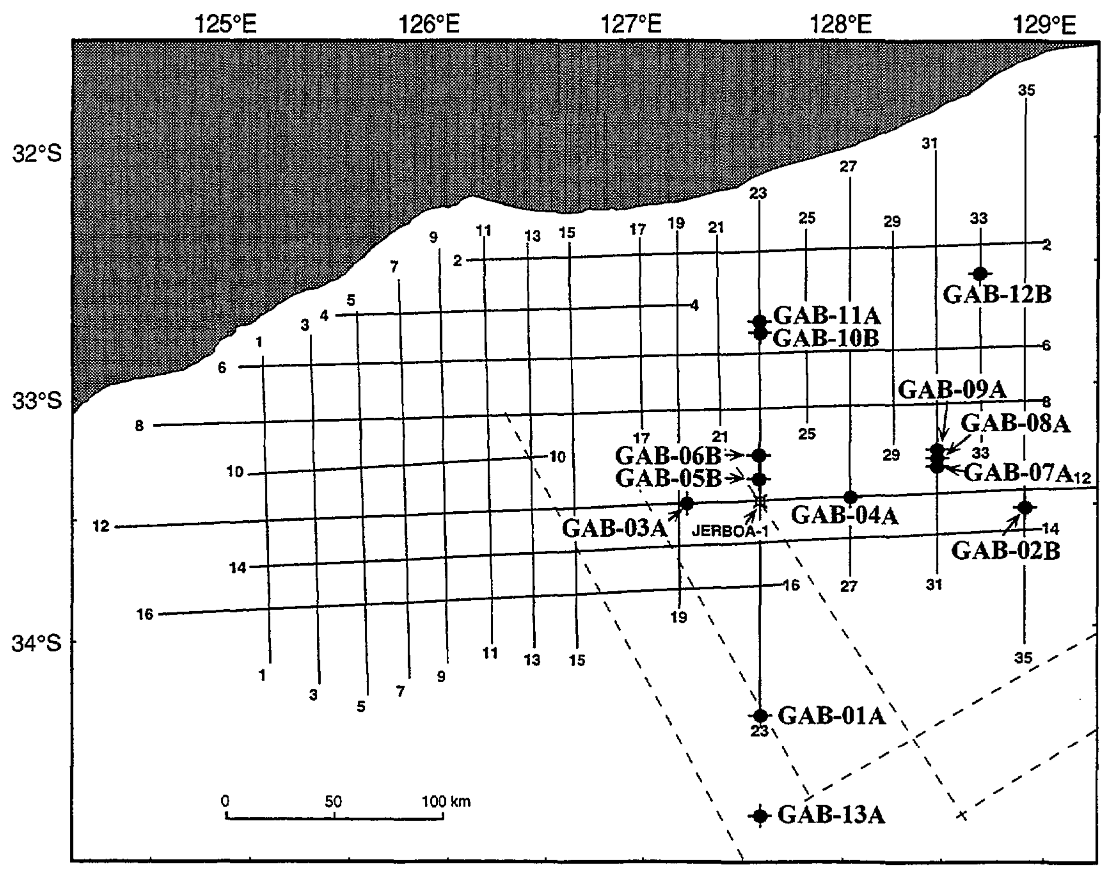


Figure 13. Map showing distribution of the proposed transect of ODP sites in the western Great Australian Bight, together with JNOC (1990-solid) and AGSO (1986 - dashed) seismic tracks.

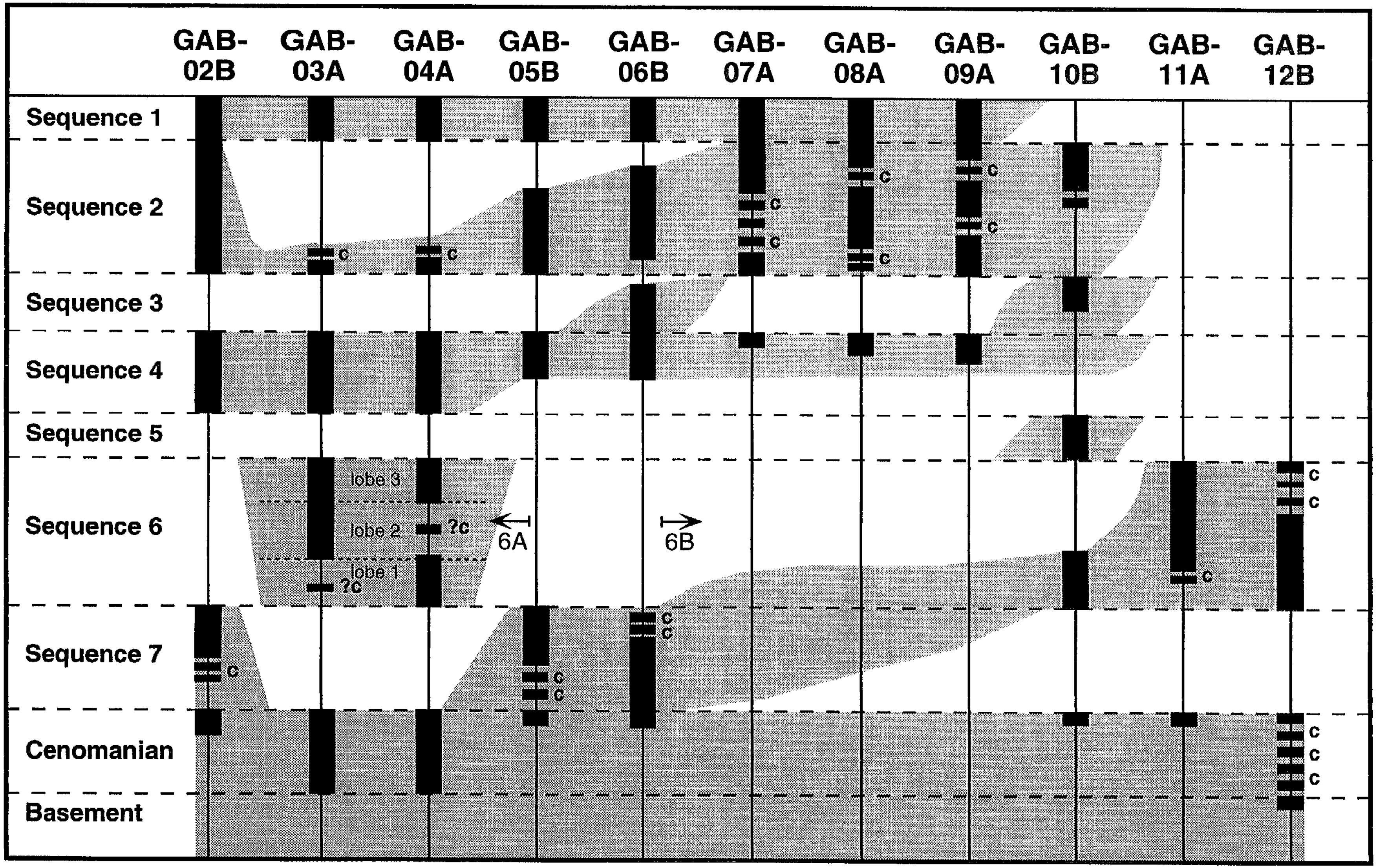
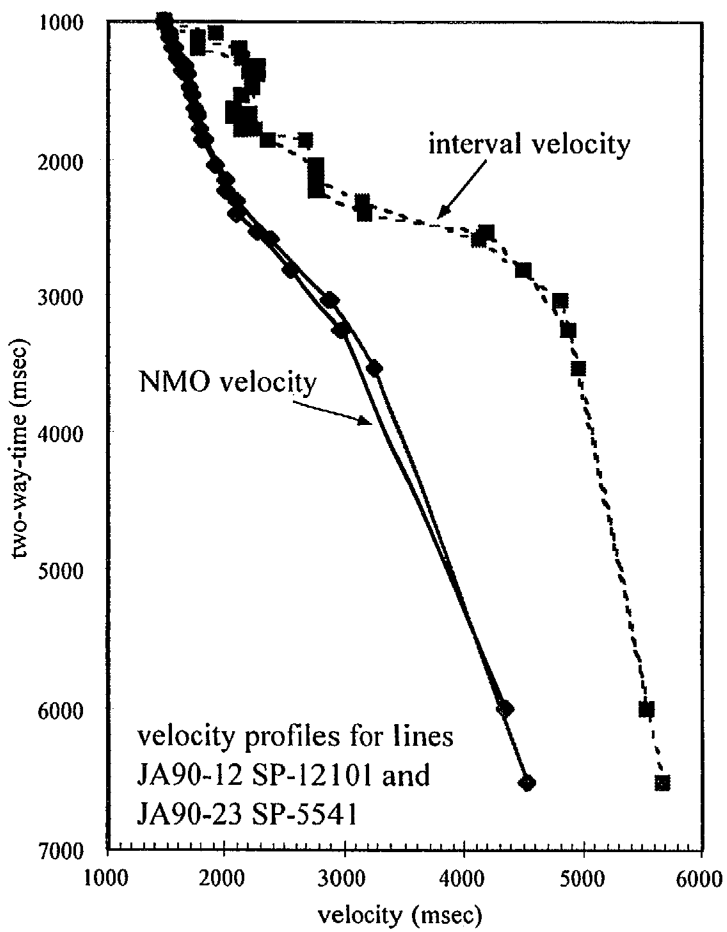
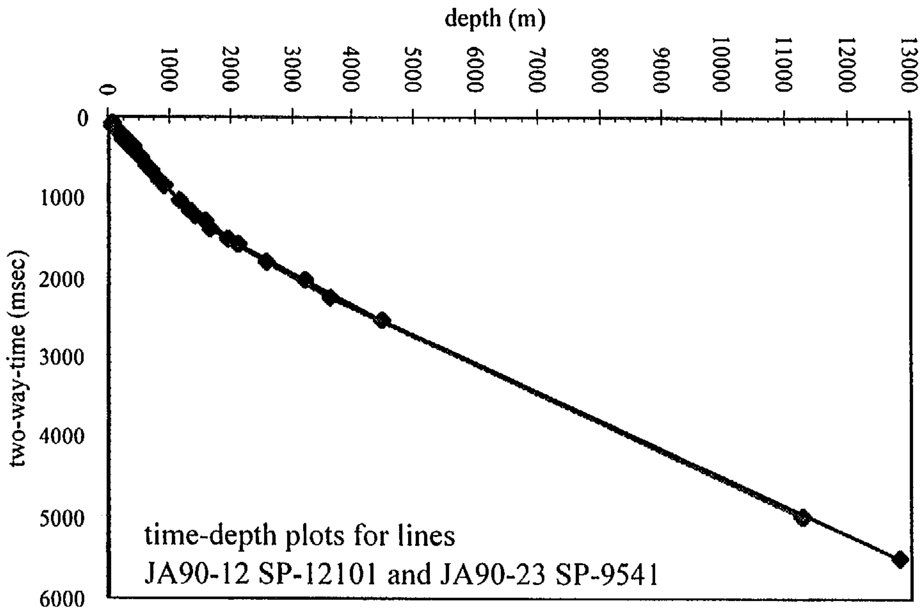


Figure 14. Chart showing sampling strategy for proposed sites GAB-02A to GAB-12B. Cenozoic sequences are not differentiated at sites GAB-01A and GAB-13A. **c** = condensed and/or discontinuous portion of sequence

Site	Easting	Northing	DD	MM	SS.S	DD	MM	SS.S	Tstart	Tend	msecs	WD	Line/cdp	(SP)		
GAB-01A	370449	6193064	34	23	44.2	127	35	26.3	5180	5888	708	3860 m	23/19000	(SP9541)		
GAB-02B	491166	6288874	33	32	22.5	128	54	17.4	1376	2456	1080	1039 m	35/14889	(SP7485)		
GAB-03A	337251	6290572	33	30	42.9	127	14	51.8	900	1404	504	680 m	12/21513	(SP10797)		
GAB-04A	411728	6293692	33	29	33.1	128	02	59.2	992	1632	640	750 m	12/27481	(SP13781)	27/3000	(SP1541)
GAB-05B	370009	6301252	33	25	12.4	127	36	06.7	640	1252	612	482 m	23/10297	(SP5189)		
GAB-06B	369934	6312749	33	18	59.1	127	36	09.8	280	955	675	214 m	23/9373	(SP4727)		
GAB-07A	451753	6308915	33	21	28.0	128	28	53.1	624	1218	594	469 m	31/4096	(SP2089)		
GAB-08A	451723	6312414	33	19	34.4	128	28	52.6	416	1056	640	315 m	31/4376	(SP2229)		
GAB-09A	451694	6316501	33	17	21.7	128	28	52.3	256	836	580	196 m	31/4703	(SP2391)		
GAB-10B	369628	6369420	32	48	19.3	127	36	27.1	60	440	380	52 m	23/4825	(SP2453)		
GAB-11A	369599	6374547	32	45	32.8	127	36	28.5	60	452	392	51 m	23/4413	(SP2247)		
GAB-12B	471150	6397272	32	33	41.3	128	41	33.6	56	424	368	50 m	33/1617	(SP849)		
GAB-13A	371118	6145172	34	49	38.9	127	35	26.3	5950	6900	950	4465 m	*			

Summary of proposed ODP sites, showing location (cartesian and geographic coordinates), site range in msecs, water depth, and location on seismic lines (cdp and SP). * Site GAB-13A is located beyond the seaward end of JA90-23, adjacent to AGSO Line S65-01P5.





Velocity analyses for SP-12101 on seismic line JA90-12 and SP-9541 on seismic line JA90-23, adjacent to oil exploration drillhole JERBOA-1 (located at SP-12111 on JA90-12 and SP-5565 on JA90-23). NMO (stacking) velocities are used to derive interval velocity profiles and time-depth curves.

4.1 SITES GAB-01A, GAB-02B AND GAB-13A

Sites GAB-01A (southern Australian upper continental rise), GAB-02B (mid-upper slope), and GAB-13A (middle continental rise) are paleoceanographic sites located to intersect sections that collectively span the entire Cenozoic succession, and a substantial part of the late Cretaceous section. These sites comprise the deep-water component of the shelf-to-basin transect. Site GAB-13A is the reinstatement of an earlier site from the 1993 proposal, retained as it now appears likely that the shallow water sites GAB-10B to GAB-12B (in 50-55 m water depth) will not be accessible with the *Joides Resolution*. This additional site is also in response to a panel request for greater penetration into the late Cretaceous for paleoceanographic purposes.

Principal Objective:

► to obtain a complete record of the Cenozoic section in a deep oceanic setting, with the principal aim of elucidating the evolution of the circum-Antarctic Current within the evolving seaway between Australia and Antarctica. As the condensed section in Jerboa-1 contains early Oligocene faunas, there is a high probability that the intermediate and deep pelagic successions will together contain a more expanded record of this critically important time of Antarctic ice cap evolution and Southern Ocean paleoceanographic development.

Additional Objective:

► to determine depositional and diagenetic facies in mid-upper slope and continental rise settings.

► to recover a Cretaceous and condensed Cenozoic section recording the history of CCD fluctuations and a partial history of deep water mass variations during evolution of the Southern Ocean

Note: because this is essentially a starved margin, there are unlikely to be major sediment gravity flow components at any of these sites.

ODP Site Summary Form8/93 Fill out one form for each proposed site and attach to proposal

Title of Proposal:	Cenozoic cool-water carbonates of the Great Australian Bight.
Site-specific Objective(s) (List of general objectives must be inc. in proposal)	- penetrate deep-water section on upper continental rise for paleoceanographic record (reflecting opening of the Southern Ocean and development of the circum-Antarctic Current)

	Proposed Site	Alternate Site
Site Name:	Great Australian Bight-1 (GAB-01A)	
Area:	upper continental rise, Great Australian Bight	
Lat./Long.:	34° 23' 44.2"S 127° 35' 26.3"E	
Water Depth:	3860 m	
Sed. Thickness:	3400 msec TWT; ≈5960 m	
Total penetration:	708 msec TWT; ≈740 m	

	Sediments	Basement
Penetration:	708 msec TWT; ≈740 m	Nil
Lithology(ies):	705 m variably cemented wackestone and grainstone; 35 m indurated muddy sandstone	Precambrian granodiorite / granitic gneiss

Coring (check):	1-2-3√-**APC√** VPC* **XCB√** MDCB* PCS **RCB√** DCS* Re-entry
Downhole measurements	Full downhole logging suite
Estimate days on site	5.5-6.5

*Systems currently under development

Target(s) (see Proposal Submission Guidelines): A√ B√ C D E F G (check)

Site Survey Information (see Proposal Submission Guidelines for details and requirements):

		Check	Details of available data and data that is still to be collected
01	SCS deep penetration		
02	SCS High Resolution		
03	MCS and velocity	√	Airgun MCS available now; high-res. MCS to be collected during site surveys
04	Seismic grid		To be collected during site surveys
05	Refraction		
06	3.5 or 12 kHz		Both 3.5 and 12 kHz data to be collected during site surveys
07	Swath bathymetry		
08	H.-res side-looking sonar		
09	Photography/video		
10	Heat flow		
11	Magnetics/gravity	√	Additional magnetic and gravity data to be collected during site surveys
12	Coring		Gravity / piston coring to be undertaken during site surveys
13	Rock sampling		
14	Current meter		
15	Other		

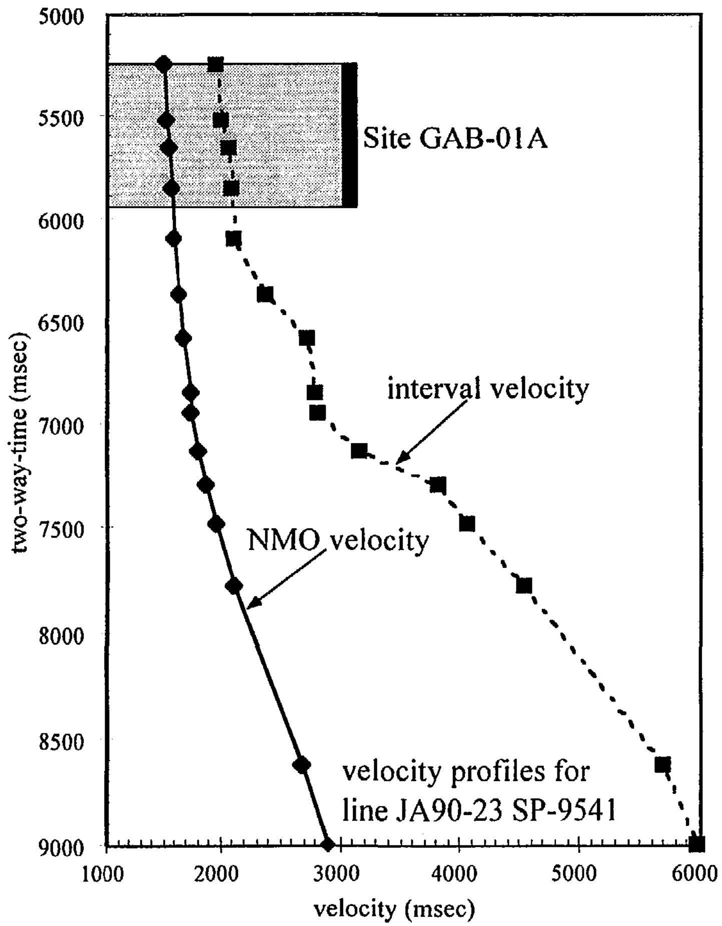
Weather, Ice, Surface Currents: Frequent storms at any time of year - however, summer (Dec-Feb) is optimum weather time

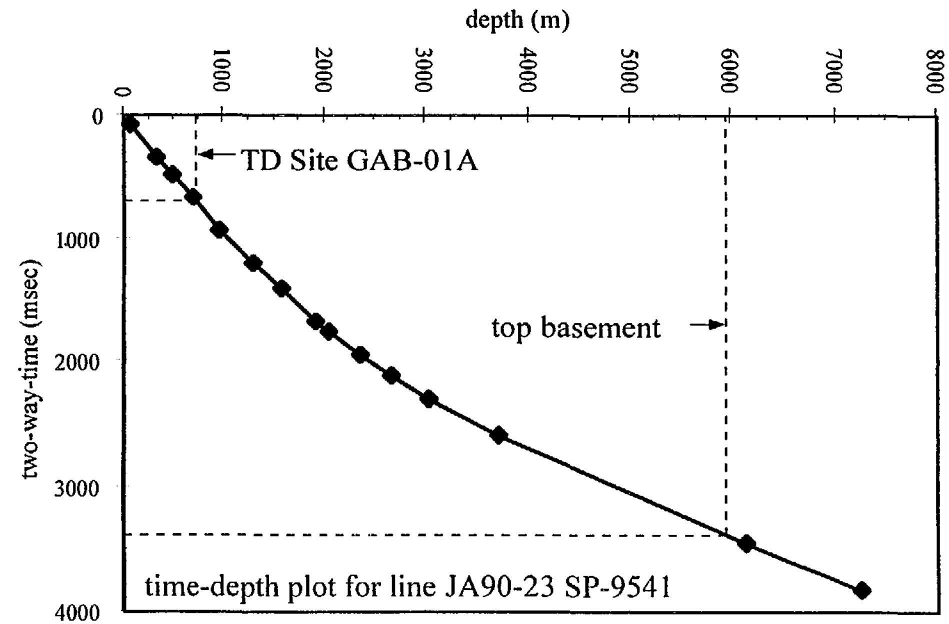
Seabed Hazards:

Territorial Jurisdiction: Australia (Western Australia)

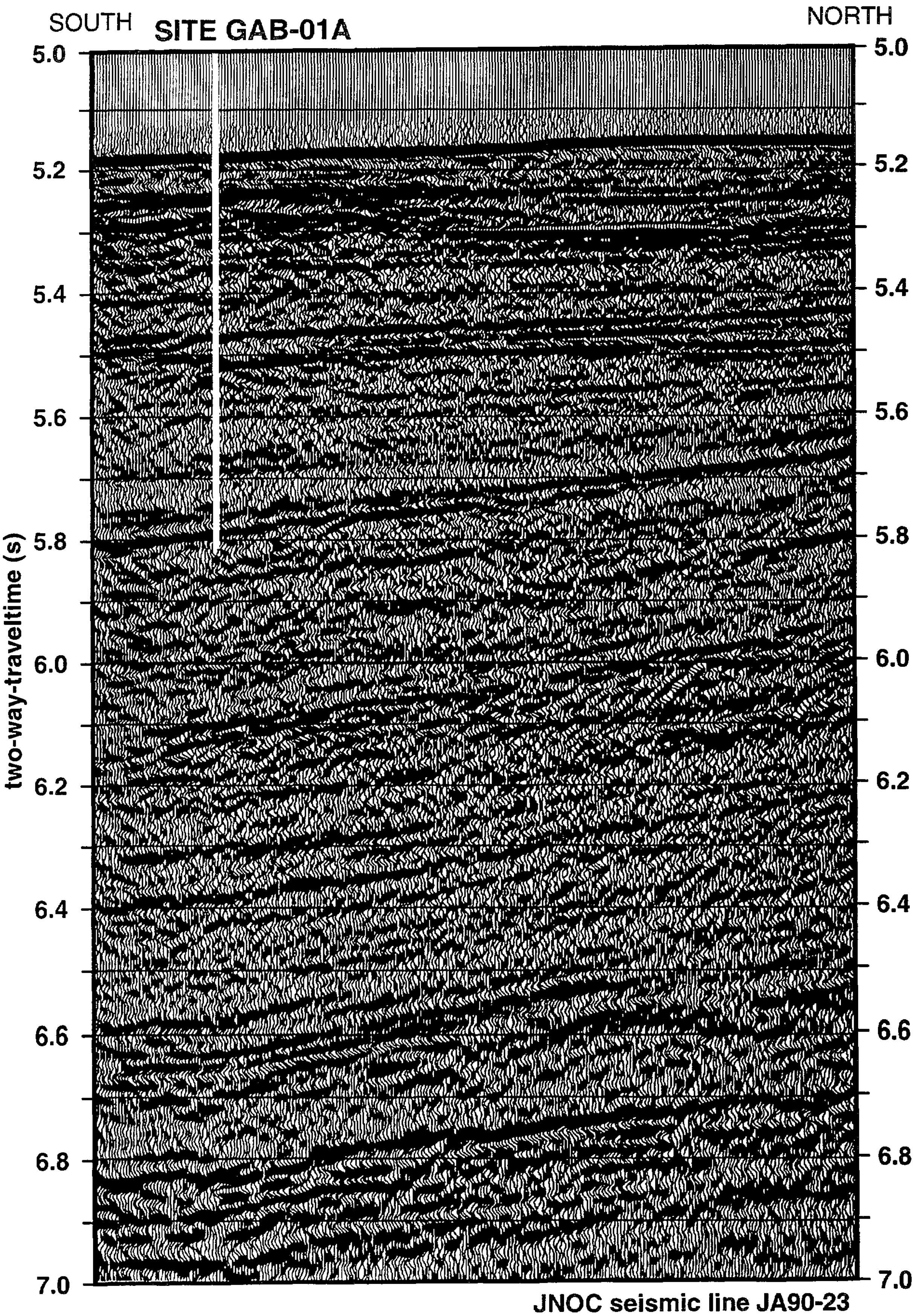
Other Remarks: Target is on seismic line JA90-23; cdp 19000 (SP 9541)

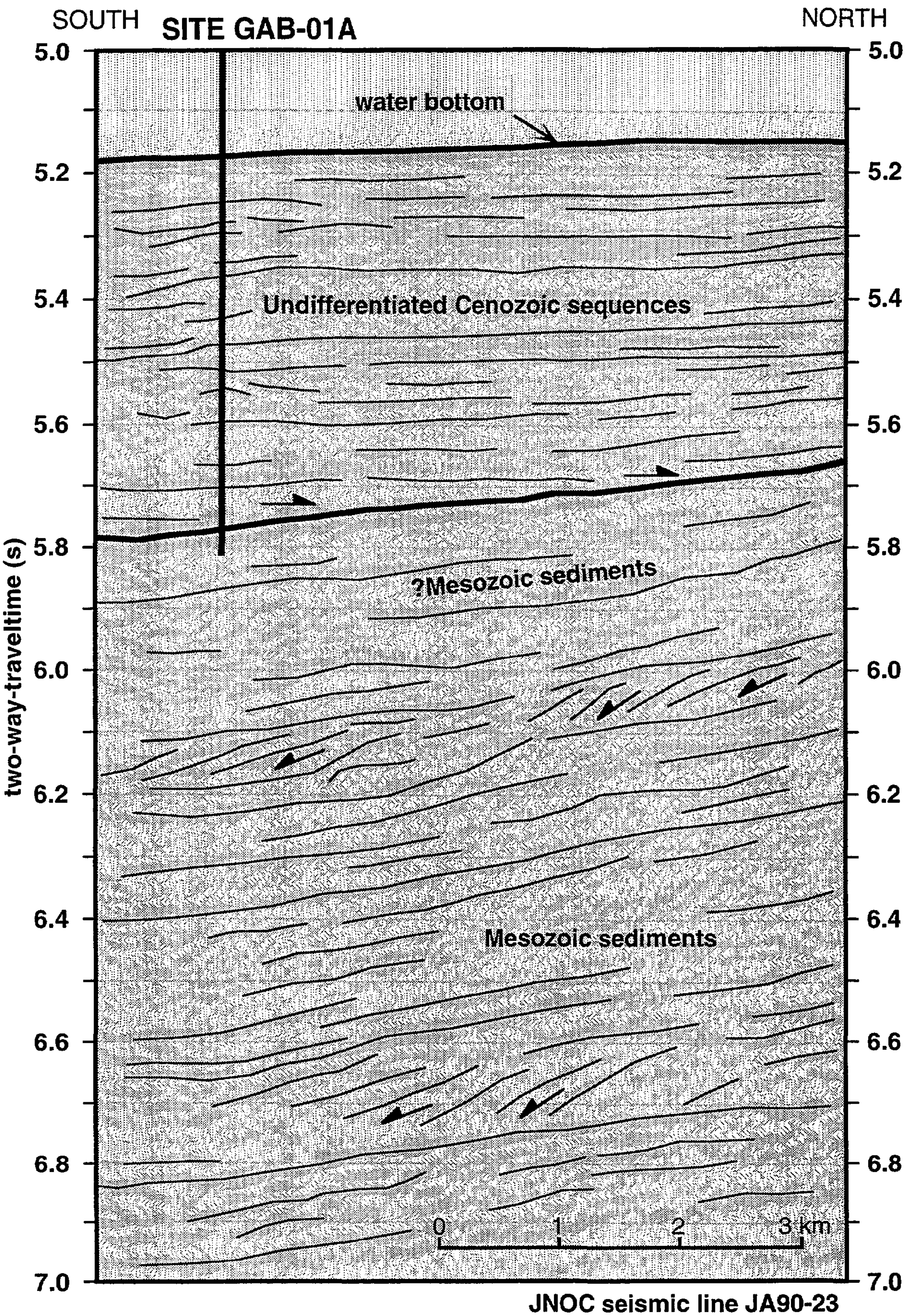
	Name/Address	Phone/FAX/Email
Contact Proponents:	Dr D.A. Feary, AGSO, Dept. Geology & Geophys., University of Sydney, Sydney 2006, AUSTRALIA	Phone: 61-2-351-2918; Fax: 61-2-351-0184 e-mail: dfeary@es.su.oz.au
	Dr N.P James, Department of Geological Sciences, Kingston, Ontario K7L 3N6, CANADA	Phone: 1-613-545-6170; Fax: 1-613-545-6592 e-mail: james@geol.queensu.ca





Velocity analysis for SP-9541 on seismic line JA90-23, corresponding to ODP Site GAB-01A. NMO (stacking) velocities are used to derive an interval velocity profile and a time-depth curve.


SOUTH
SITE GAB-01A
NORTH
5.0
5.2
5.4
5.6
5.8
6.0
6.2
6.4
6.6
6.8
7.0
two-way-traveltime (s)
JNOC seismic line JA90-23


SOUTH
SITE GAB-01A
NORTH
5.0
5.2
5.4
5.6
5.8
6.0
6.2
6.4
6.6
6.8
7.0
two-way-traveltime (s)
water bottom
Undifferentiated Cenozoic sequences
?Mesozoic sediments
Mesozoic sediments
0
1
2
3 km
JNOC seismic line JA90-23

ODP Site Summary Form8/93 Fill out one form for each proposed site and attach to proposal

Title of Proposal:	Cenozoic cool-water carbonates of the Great Australian Bight.
Site-specific Objective(s) (List of general objectives must be inc. in proposal)	- penetrate intermediate water depth section on middle-upper slope for paleoceanographic record (reflecting opening of the Southern Ocean and development of the circum-Antarctic Current)

	Proposed Site	Alternate Site
Site Name:	Great Australian Bight-2 (GAB-02B)	
Area:	middle-upper slope, Great Australian Bight	
Lat./Long.:	33° 32' 22.5"S 128° 54' 17.4"E	
Water Depth:	1039 m	
Sed. Thickness:	2680 msec TWT; ≈4610 m	
Total penetration:	1080 msec TWT; ≈1575 m	

	Sediments	Basement
Penetration:	1080 msec TWT; ≈1575 m	Nil
Lithology(ies):	1220 m variably cemented wackestone and grainstone; 355 m indurated muddy sandstone	Precambrian granodiorite / granitic gneiss
Coring (check):	1-2-3√-APC√ VPC* XCB√ MDCB* PCS RCB√ DCS* Re-entry	
Downhole measurements	Full downhole logging suite	
Estimate days on site	7.5-8.5	

*Systems currently under development

Target(s) (see Proposal Submission Guidelines): A√ B√ C D E F G (check)

Site Survey Information (see Proposal Submission Guidelines for details and requirements):

		Check	Details of available data and data that is still to be collected
01	SCS deep penetration		
02	SCS High Resolution		
03	MCS and velocity	√	Airgun MCS available now; high-res. MCS to be collected during site surveys
04	Seismic grid		To be collected during site surveys
05	Refraction		
06	3.5 or 12 kHz		Both 3.5 and 12 kHz data to be collected during site surveys
07	Swath bathymetry		
08	H.-res side-looking sonar		
09	Photography/video		
10	Heat flow		
11	Magnetics/gravity	√	Additional magnetic and gravity data to be collected during site surveys
12	Coring		Gravity / piston coring to be undertaken during site surveys
13	Rock sampling		
14	Current meter		
15	Other		

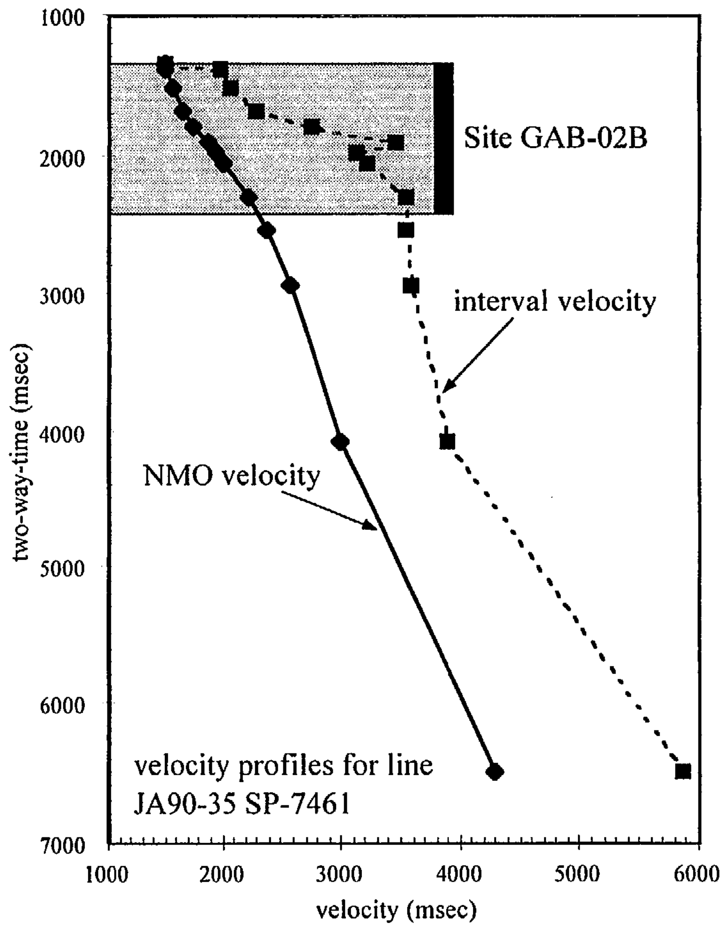
Weather, Ice, Surface Currents: Frequent storms at any time of year - however, summer (Dec-Feb) is optimum weather time

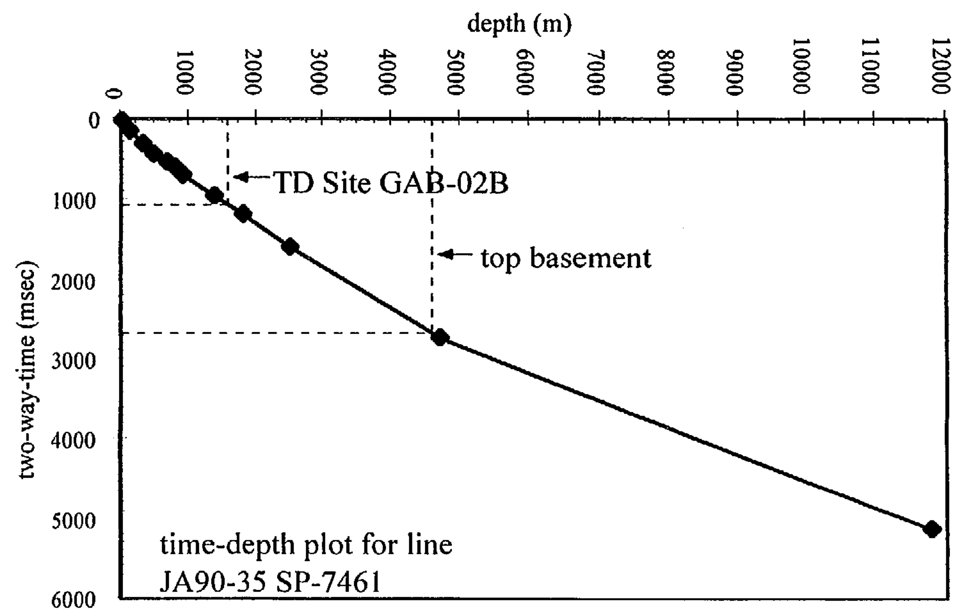
Seabed Hazards:

Territorial Jurisdiction: Australia (Western Australia)

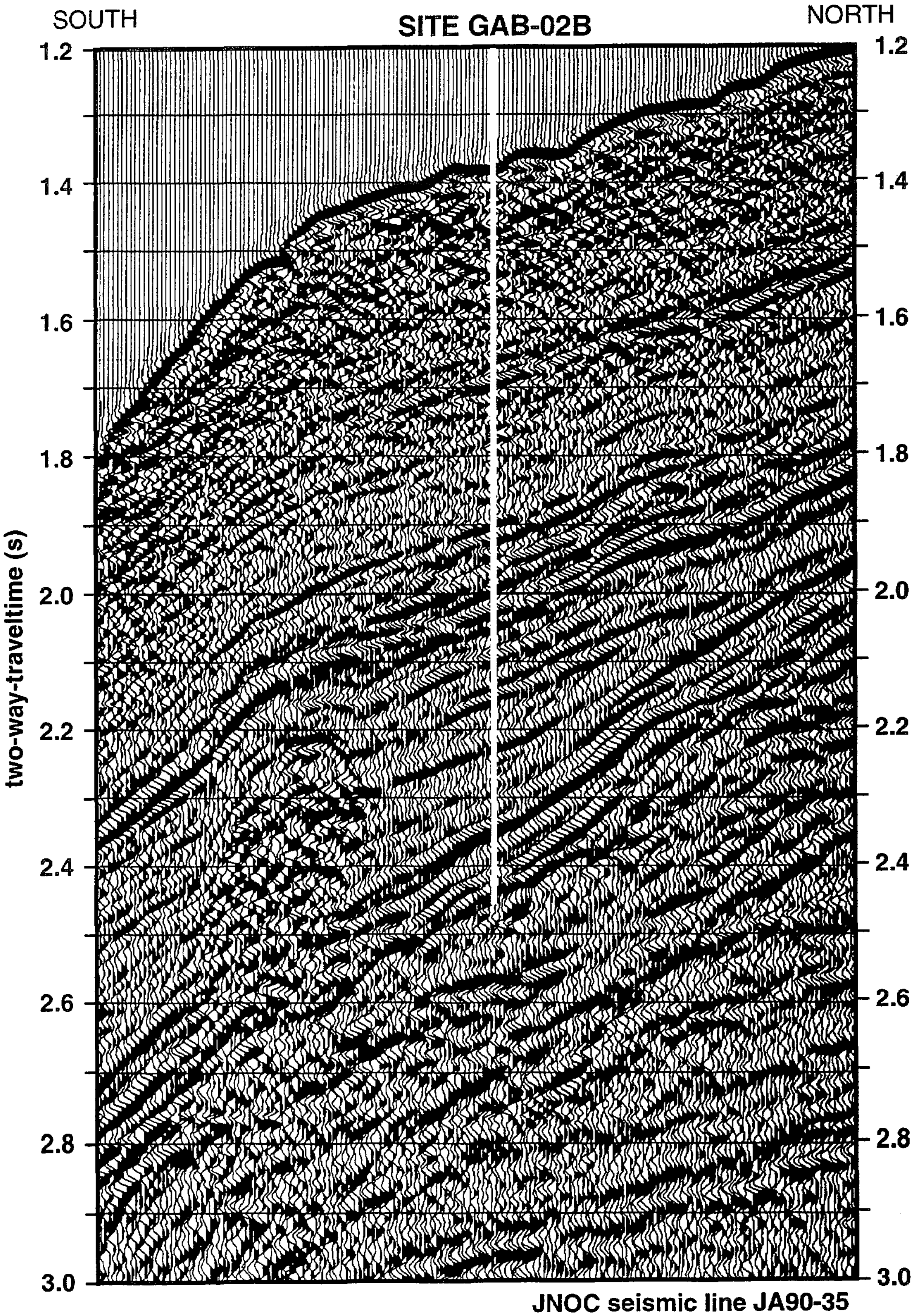
Other Remarks: Target is on seismic line JA90-35; cdp 14889 (SP 7485)

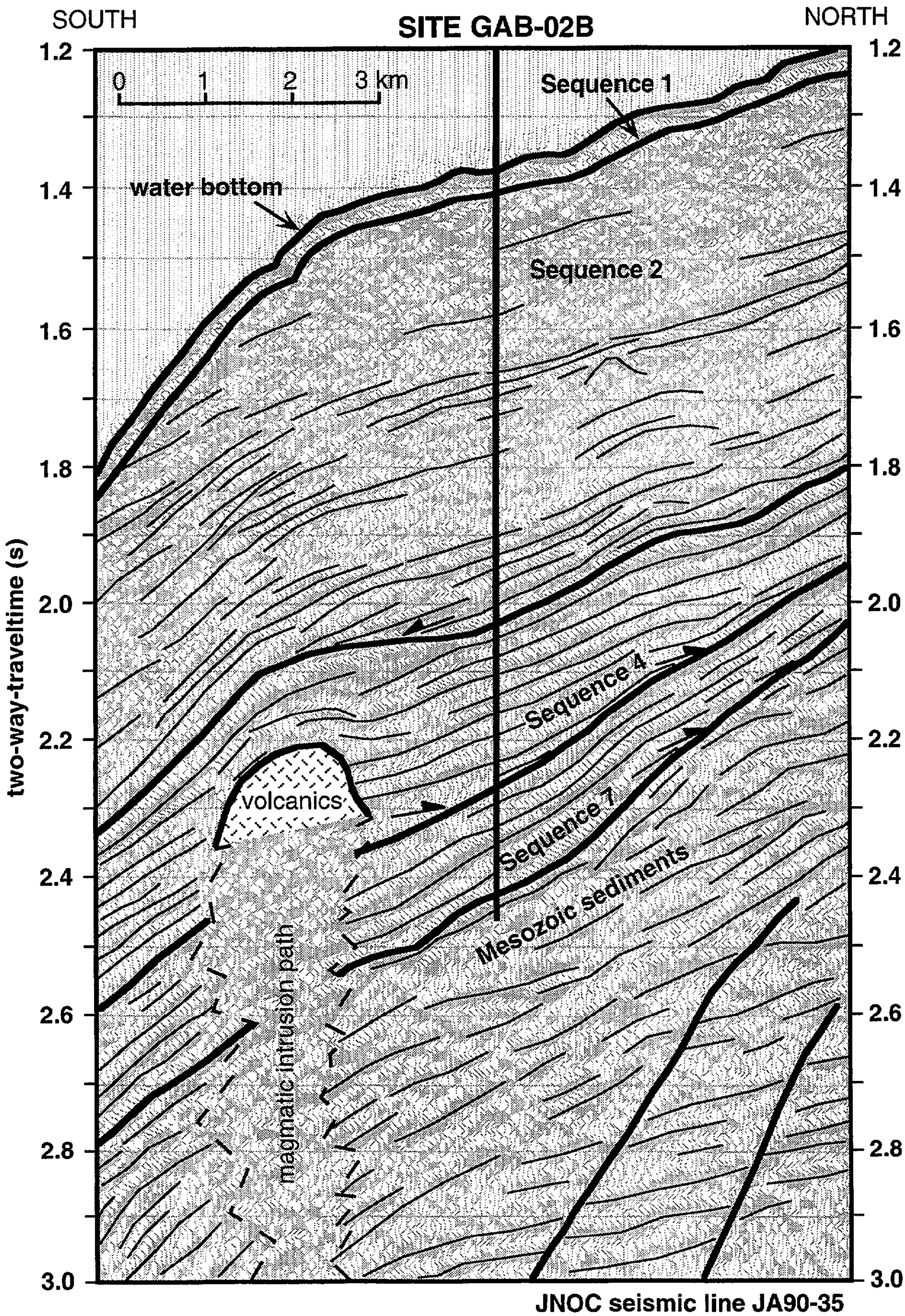
	Name/Address	Phone/FAX/Email
Contact Proponents:	Dr D.A. Feary, AGSO, Dept. Geology & Geophys., University of Sydney, Sydney 2006, AUSTRALIA	Phone: 61-2-351-2918; Fax: 61-2-351-0184 e-mail: dfeary@es.su.oz.au
	Dr N.P James, Department of Geological Sciences, Kingston, Ontario K7L 3N6, CANADA	Phone: 1-613-545-6170; Fax: 1-613-545-6592 e-mail: james@geol.queensu.ca





Velocity analysis for SP-7461 on seismic line JA90-35, adjacent to ODP Site GAB-02B (SP-7485). NMO (stacking) velocities are used to derive an interval velocity profile and a time-depth curve.


SOUTH
SITE GAB-02B
NORTH
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
3.0
two-way-traveltime (s)
JNOC seismic line JA90-35


SOUTH
SITE GAB-02B
NORTH
0 1 2 3 km
Sequence 1
water bottom
Sequence 2
Sequence 4
Sequence 7
volcanics
magmatic intrusion path
Mesozoic sediments
two-way-traveltime (s)
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
3.0
JNOC seismic line JA90-35

ODP Site Summary Form8/93 Fill out one form for each proposed site and attach to proposal

Title of Proposal:	Cenozoic cool-water carbonates of the Great Australian Bight.
Site-specific Objective(s) (List of general objectives must be inc. in proposal)	- penetrate deep-water section on middle continental rise for paleoceanographic record (reflecting opening of the Southern Ocean and development of the circum-Antarctic Current)

	Proposed Site	Alternate Site
Site Name:	Great Australian Bight-13 (GAB-13A)	
Area:	middle continental rise, Great Australian Bight	
Lat./Long.:	34° 49 39.0"S 127° 34 57.0"E	
Water Depth:	4465 m	
Sed. Thickness:	>3.5 km	
Total penetration:	950 msec TWT; ≈1045 m	

	Sediments	Basement
Penetration:	950 msec TWT; ≈1045 m	Nil
Lithology(ies):	520 m variably cemented wackestone and grainstone; 525 m marls/calcareous mudstone	Precambrian granodiorite / granitic gneiss
Coring (check):	1-2-**3√-APC√** VPC* **XCB√** MDCB* PCS **RCB√** DCS* Re-entry	
Downhole measurements	Full downhole logging suite	
Estimate days on site	8.5-10.5	

*Systems currently under development

Target(s) (see Proposal Submission Guidelines): A√ B√ C D E F G (check)

Site Survey Information (see Proposal Submission Guidelines for details and requirements):

		Check	Details of available data and data that is still to be collected
01	SCS deep penetration		
02	SCS High Resolution		
03	MCS and velocity		High-res. MCS to be collected during site surveys
04	Seismic grid		To be collected during site surveys
05	Refraction		
06	3.5 or 12 kHz		Both 3.5 and 12 kHz data to be collected during site surveys
07	Swath bathymetry		
08	H.-res side-looking sonar		
09	Photography/video		
10	Heat flow		
11	Magnetics/gravity		Additional magnetic and gravity data to be collected during site surveys
12	Coring		Gravity / piston coring to be undertaken during site surveys
13	Rock sampling		
14	Current meter		
15	Other		

Weather, Ice, Surface Currents: Frequent storms at any time of year - however, summer (Dec-Feb) is optimum weather time

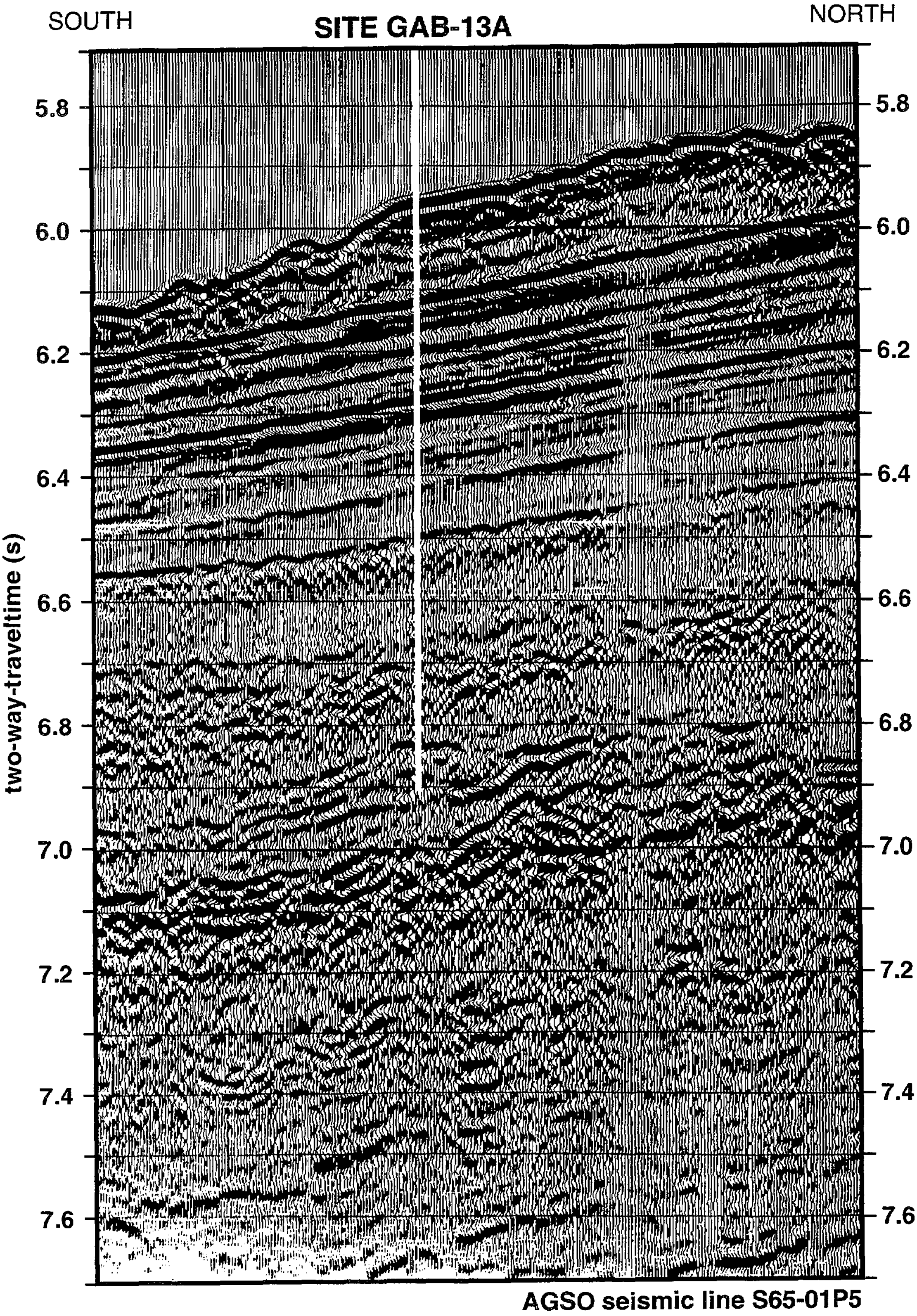
Seabed Hazards:

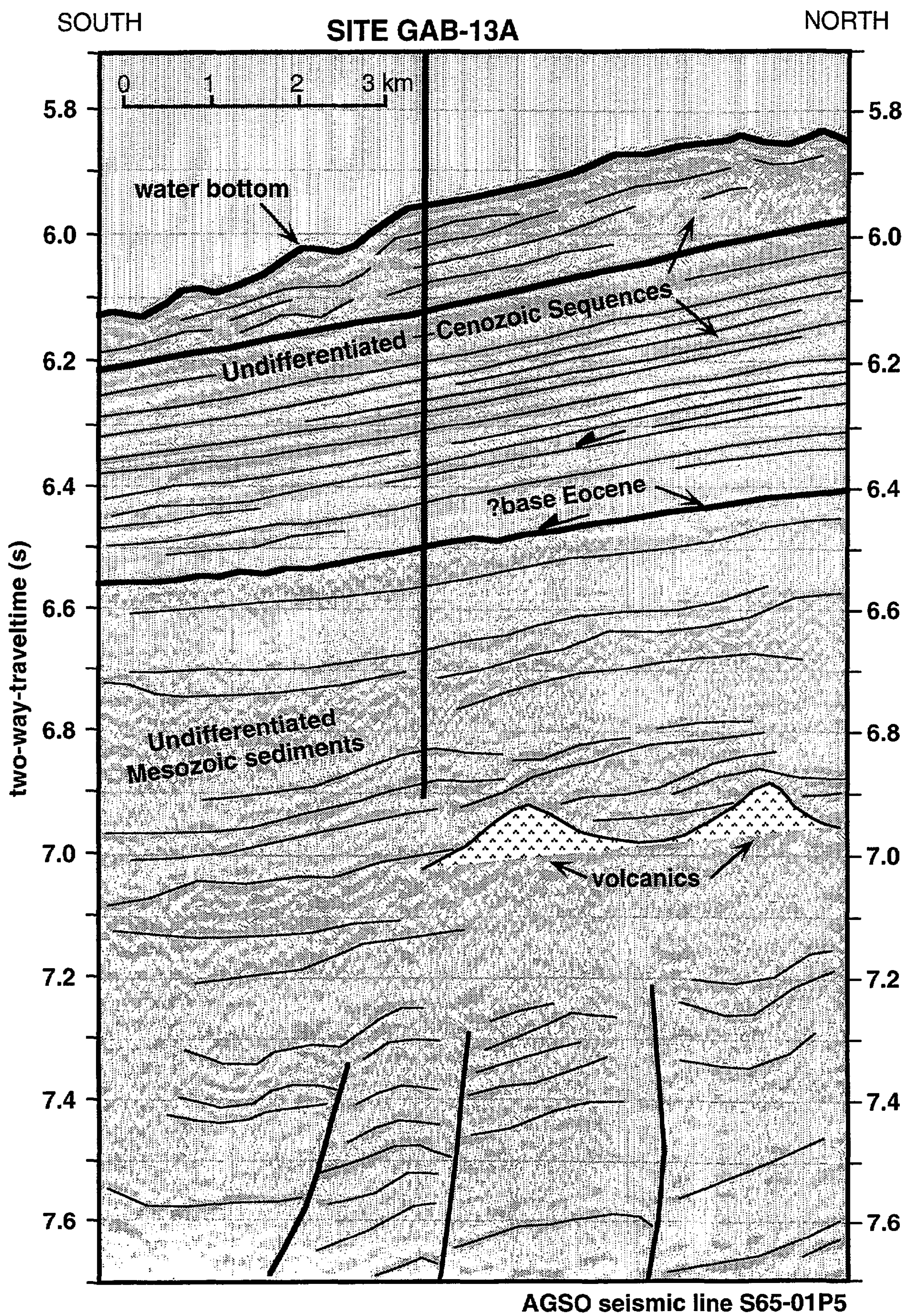
Territorial Jurisdiction: Australia (Western Australia)

Other Remarks: Target is adjacent to seismic lines (JNOC) JA90-23 and (AGSO) S65-04

	Name/Address	Phone/FAX/Email
Contact Proponents:	Dr D.A. Feary, AGSO, Dept. Geology & Geophys., University of Sydney, Sydney 2006, AUSTRALIA	Phone: 61-2-351-2918; Fax: 61-2-351-0184 e-mail: dfeary@es.su.oz.au
	Dr N.P James, Department of Geological Sciences, Kingston, Ontario K7L 3N6, CANADA	Phone: 1-613-545-6170; Fax: 1-613-545-6592 e-mail: james@geol.queensu.ca

As Site GAB-13A does not lie on an existing seismic line, there are no directly applicable stacking velocities to use for time-depth calculations. As part of the site surveys to be collected in January-February 1996 (see Section 2.4), a MCS seismic grid will be collected over this site; until that data is processed and the stacking velocities are available, we have based time-depth calculations for this site on the similar site GAB-01A.


SOUTH
SITE GAB-13A
NORTH
two-way-traveltime (s)
5.8
6.0
6.2
6.4
6.6
6.8
7.0
7.2
7.4
7.6
AGSO seismic line S65-01P5


SOUTH
SITE GAB-13A
NORTH
0 1 2 3 km
5.8
6.0
6.2
6.4
6.6
6.8
7.0
7.2
7.4
7.6
two-way-traveltime (s)
water bottom
Undifferentiated
Cenozoic Sequences
?base Eocene
Undifferentiated
Mesozoic sediments
volcanics
AGSO seismic line S65-01P5

4.2 SITES GAB-03A AND GAB-04A

Sites GAB-03A and GAB-04A are located to intersect the Eocene to early Middle Miocene section deposited in lobes on the upper slope, coeval with deposition of the extensive carbonate platform on the continental shelf. In addition, these sites will also intersect an early Neogene succession poorly sampled at other sites; a highly condensed late Neogene succession; and the upper part of the marine Cenomanian section at Site GAB-04A.

Principal Objectives:

- ► to collect a detailed record of Paleogene-early Neogene temperate to subtropical, mid-latitude sedimentation in an upper slope environment. Low sea-level hiatuses within the carbonate platform sequence further inshore at Sites GAB-11A and GAB-12B should be represented by thin sequences on the upper slope. For portions of the succession occurring at both locations, direct comparison of shelf and off-shelf depositional facies will be possible.
- ► to recover a record of marine flooding of the evolving rift basin in the Cenomanian (Site GAB-04A).

Additional Objectives:

- ► to determine the characteristics of upper slope, cool-water carbonate facies within the Neogene succession (Sequences 2 and 4).
- ► to determine paleoceanographic parameters within an upper slope setting in Sequences 2 and 4, to complement other components of the shelf-to-basin transect.
- ► to evaluate sea-level control on Neogene facies within an upper slope setting; in particular, to evaluate stratigraphic response to eustatic oscillations by comparison with equivalent time intervals in shallow shelf and deep oceanic situations.
- ► to evaluate the diagenetic history and processes within Neogene facies in an upper slope setting.

ODP Site Summary Form 8/93 Fill out one form for each proposed site and attach to proposal

Title of Proposal:	Cenozoic cool-water carbonates of the Great Australian Bight.
Site-specific Objective(s) (List of general objectives must be inc. in proposal)	- penetrate Paleogene lowstand sediment lobes to evaluate sealevel control on deep-water carbonates deposited coevally with shelf carbonate platform (?reciprocal sedimentation)

	Proposed Site	Alternate Site
Site Name:	Great Australian Bight-3 (GAB-03A)	
Area:	Eyre Terrace, Great Australian Bight	
Lat./Long.:	33° 30' 42.9"S 127° 14' 51.8"E	
Water Depth:	680 m	
Sed. Thickness:	1990 msec TWT; ≈2830 m	
Total penetration:	504 msec TWT; ≈545 m	

	Sediments	Basement
Penetration:	504 msec TWT; ≈545 m	Nil
Lithology(ies):	350 m variably-cemented wackestone with minor grainstone; 195 m muddy sandstone	Precambrian granodiorite / granitic gneiss
Coring (check):	1-2√-3-**APC**√ VPC* **XCB**√ MDCB PCS RCB DCS* Re-entry	
Downhole measurements	Full downhole logging suite	
Estimate days on site	3-4	

*Systems currently under development

Target(s) (see Proposal Submission Guidelines): A√ B√ C D E F G (check)

Site Survey Information (see Proposal Submission Guidelines for details and requirements):

		Check	Details of available data and data that is still to be collected
01	SCS deep penetration		
02	SCS High Resolution		
03	MCS and velocity	√	Airgun MCS available now; high-res. MCS to be collected during site surveys
04	Seismic grid		To be collected during site surveys
05	Refraction		
06	3.5 or 12 kHz		Both 3.5 and 12 kHz data to be collected during site surveys
07	Swath bathymetry		
08	H.-res side-looking sonar		
09	Photography/video		Bottom photographs to be collected during site surveys
10	Heat flow		
11	Magnetics/gravity	√	Additional magnetic and gravity data to be collected during site surveys
12	Coring		Gravity / piston coring to be undertaken during site surveys
13	Rock sampling		
14	Current meter		
15	Other		

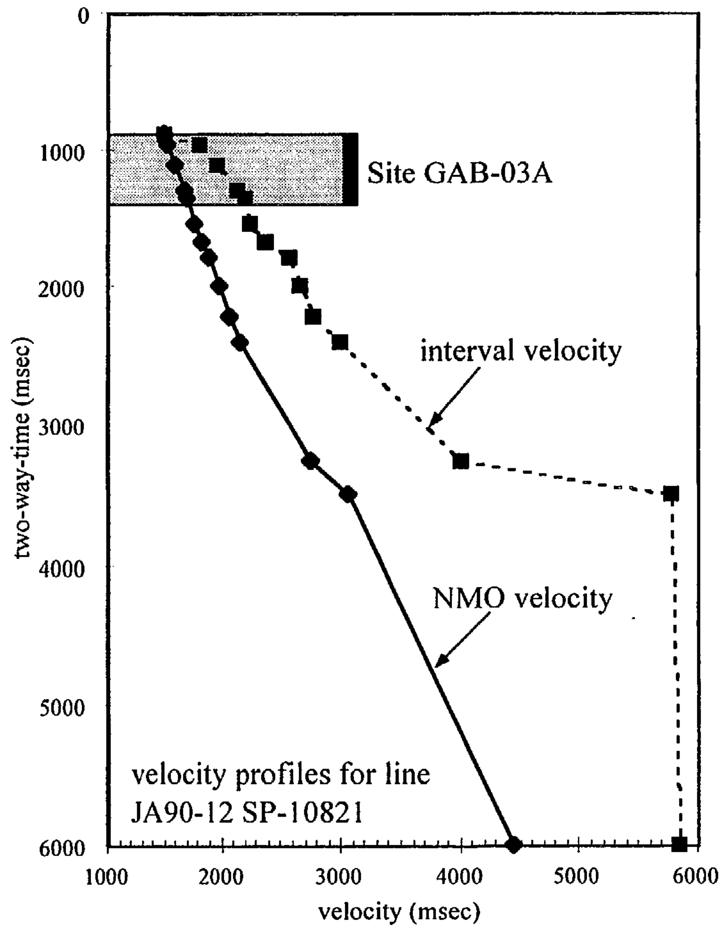
Weather, Ice, Surface Currents: Frequent storms at any time of year - however, summer (Dec-Feb) is optimum weather time

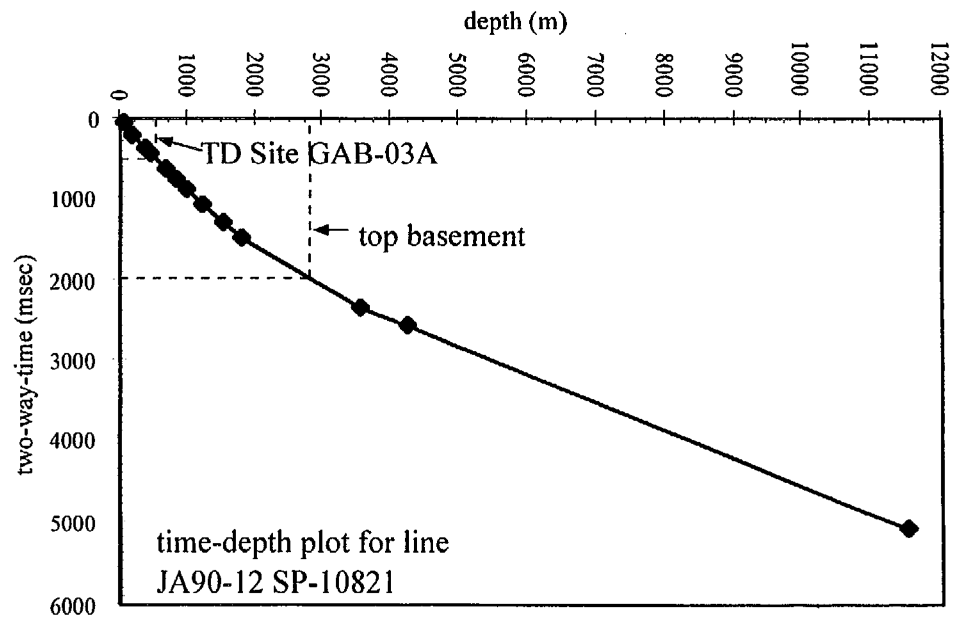
Seabed Hazards:

Territorial Jurisdiction: Australia (Western Australia)

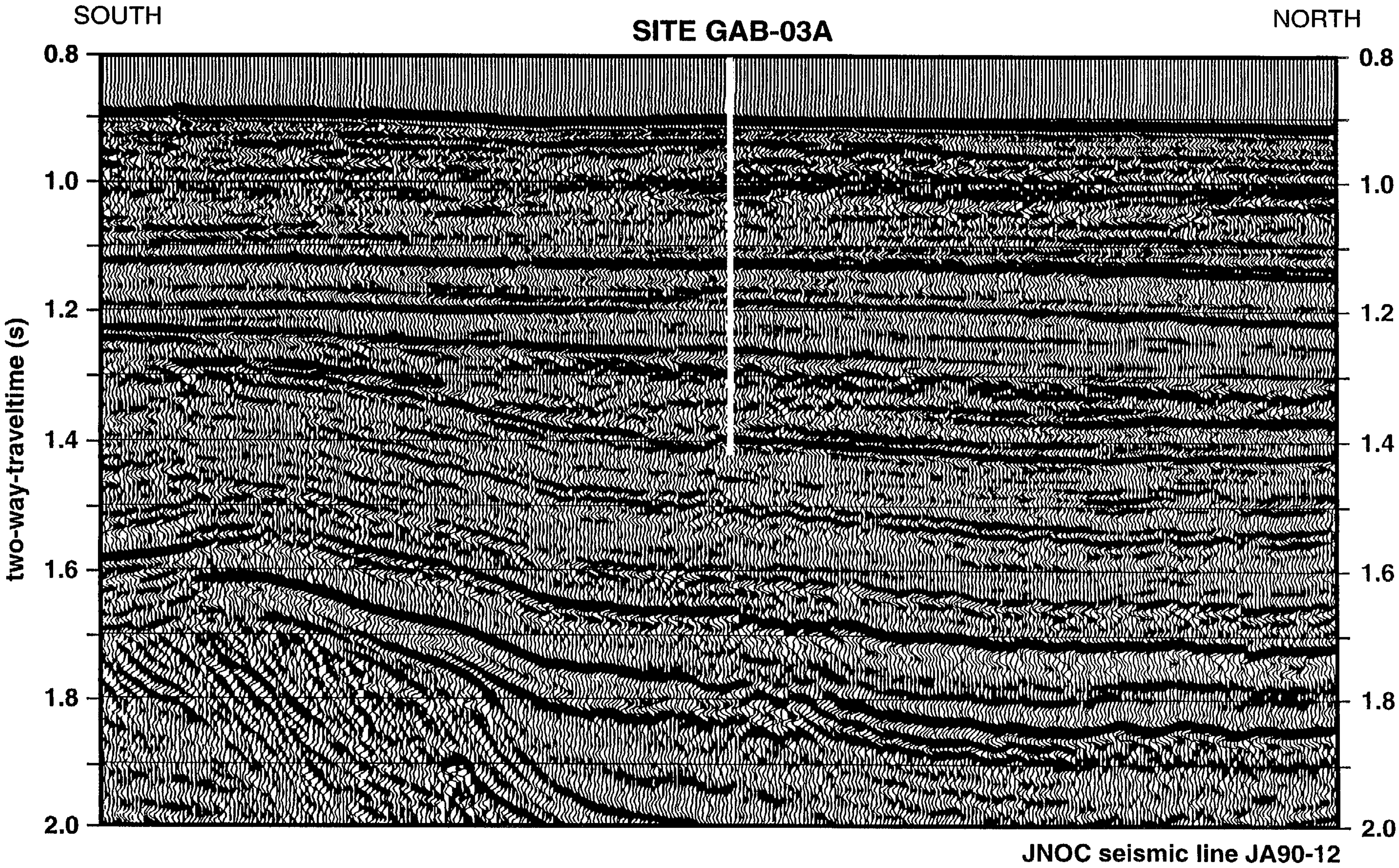
Other Remarks: Target on seismic line JA90-12; cdp 21513 (SP 10797)

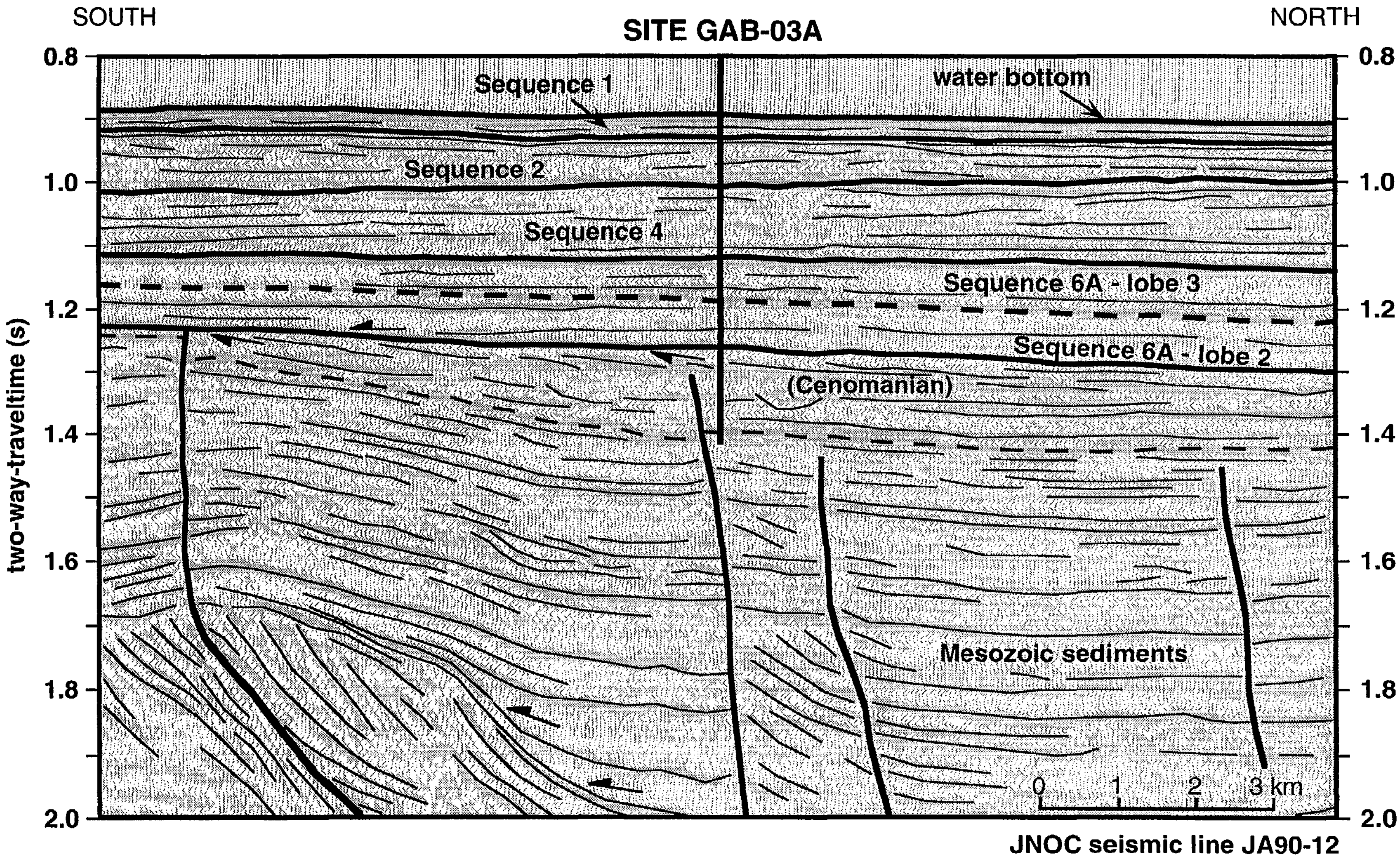
	Name/Address	Phone/FAX/Email
Contact Proponents:	Dr D.A. Feary, AGSO, Dept. Geology & Geophys., University of Sydney, Sydney 2006, AUSTRALIA	Phone: 61-2-351-2918; Fax: 61-2-351-0184 e-mail: dfeary@es.su.oz.au
	Dr N.P James, Department of Geological Sciences, Kingston, Ontario K7L 3N6, CANADA	Phone: 1-613-545-6170; Fax: 1-613-545-6592 e-mail: james@geol.queensu.ca





Velocity analysis for SP-10821 on seismic line JA90-12, adjacent to ODP Site GAB-03A (SP-10797). NMO (stacking) velocities are used to derive an interval velocity profile and a time-depth curve.


SOUTH
SITE GAB-03A
NORTH
two-way-traveltime (s)
0.8
1.0
1.2
1.4
1.6
1.8
2.0
JNOC seismic line JA90-12



SOUTH
SITE GAB-03A
NORTH
0.8
1.0
1.2
1.4
1.6
1.8
2.0
two-way-traveltime (s)
Sequence 1
water bottom
Sequence 2
Sequence 4
Sequence 6A - lobe 3
Sequence 6A - lobe 2
(Cenomanian)
Mesozoic sediments
0 1 2 3 km
JNOC seismic line JA90-12

ODP Site Summary Form 8/93 Fill out one form for each proposed site and attach to proposal

Title of Proposal:	Cenozoic cool-water carbonates of the Great Australian Bight.
Site-specific Objective(s) (List of general objectives must be inc. in proposal)	- penetrate Paleogene lowstand sediment lobes to evaluate sealevel control on deep-water carbonates deposited coevally with shelf carbonate platform (?reciprocal sedimentation); also to penetrate marine Cenomanian section

	Proposed Site	Alternate Site
Site Name:	Great Australian Bight-4 (GAB-04A)	
Area:	Eyre Terrace, Great Australian Bight	
Lat./Long.:	33° 29' 33.1"S 128° 02' 59.2"E	
Water Depth:	750 m	
Sed. Thickness:	895 msec TWT; ≈950 m	
Total penetration:	640 msec TWT; ≈680 m	

	Sediments	Basement
Penetration:	640 msec TWT; ≈680 m	Nil
Lithology(ies):	420 m variably-cemented wackestone with minor grainstone; 260 m muddy sandstone	Precambrian granodiorite / granitic gneiss
Coring (check):	1-2√-3-**APC√** VPC* **XCB√** MDCB PCS RCB DCS* Re-entry	
Downhole measurements	Full downhole logging suite	
Estimate days on site	5.5-7	

*Systems currently under development

Target(s) (see Proposal Submission Guidelines): A√ B√ C D E F G (check)

Site Survey Information (see Proposal Submission Guidelines for details and requirements):

		Check	Details of available data and data that is still to be collected
01	SCS deep penetration		
02	SCS High Resolution		
03	MCS and velocity	√	Airgun MCS available now; high-res. MCS to be collected during site surveys
04	Seismic grid		To be collected during site surveys
05	Refraction		
06	3.5 or 12 kHz		Both 3.5 and 12 kHz data to be collected during site surveys
07	Swath bathymetry		
08	H.-res side-looking sonar		
09	Photography/video		Bottom photographs to be collected during site surveys
10	Heat flow		
11	Magnetics/gravity	√	Additional magnetic and gravity data to be collected during site surveys
12	Coring		Gravity / piston coring to be undertaken during site surveys
13	Rock sampling		
14	Current meter		
15	Other		

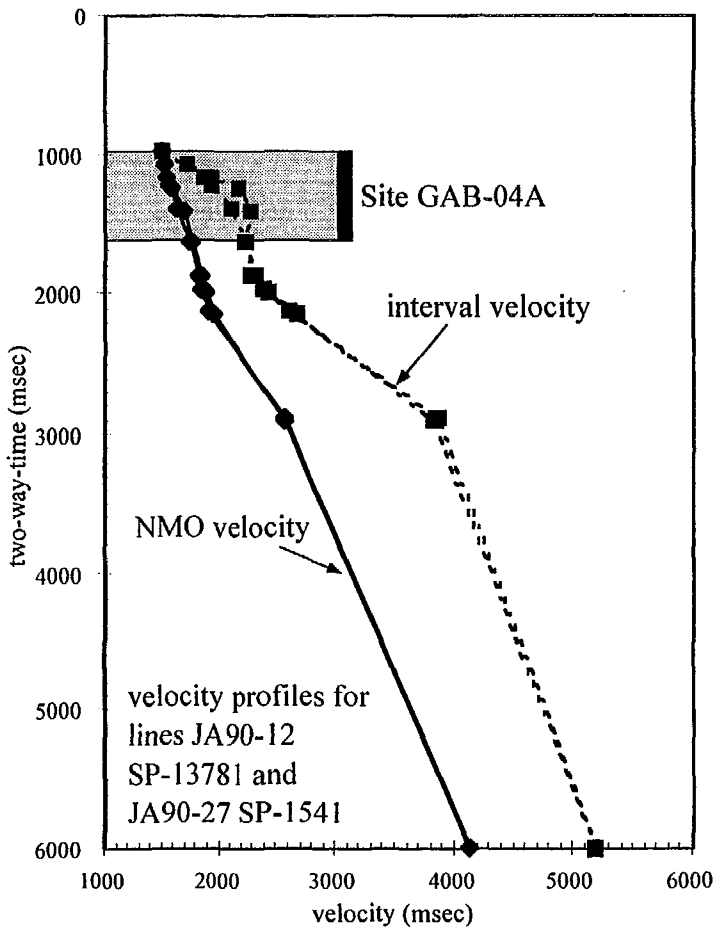
Weather, Ice, Surface Currents: Frequent storms at any time of year - however, summer (Dec-Feb) is optimum weather time

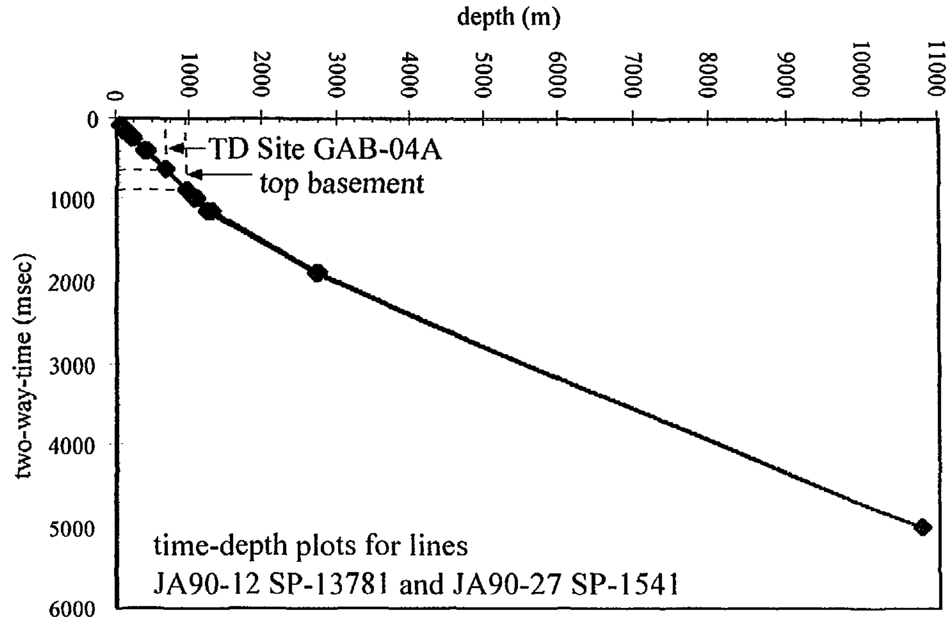
Seabed Hazards:

Territorial Jurisdiction: Australia (Western Australia)

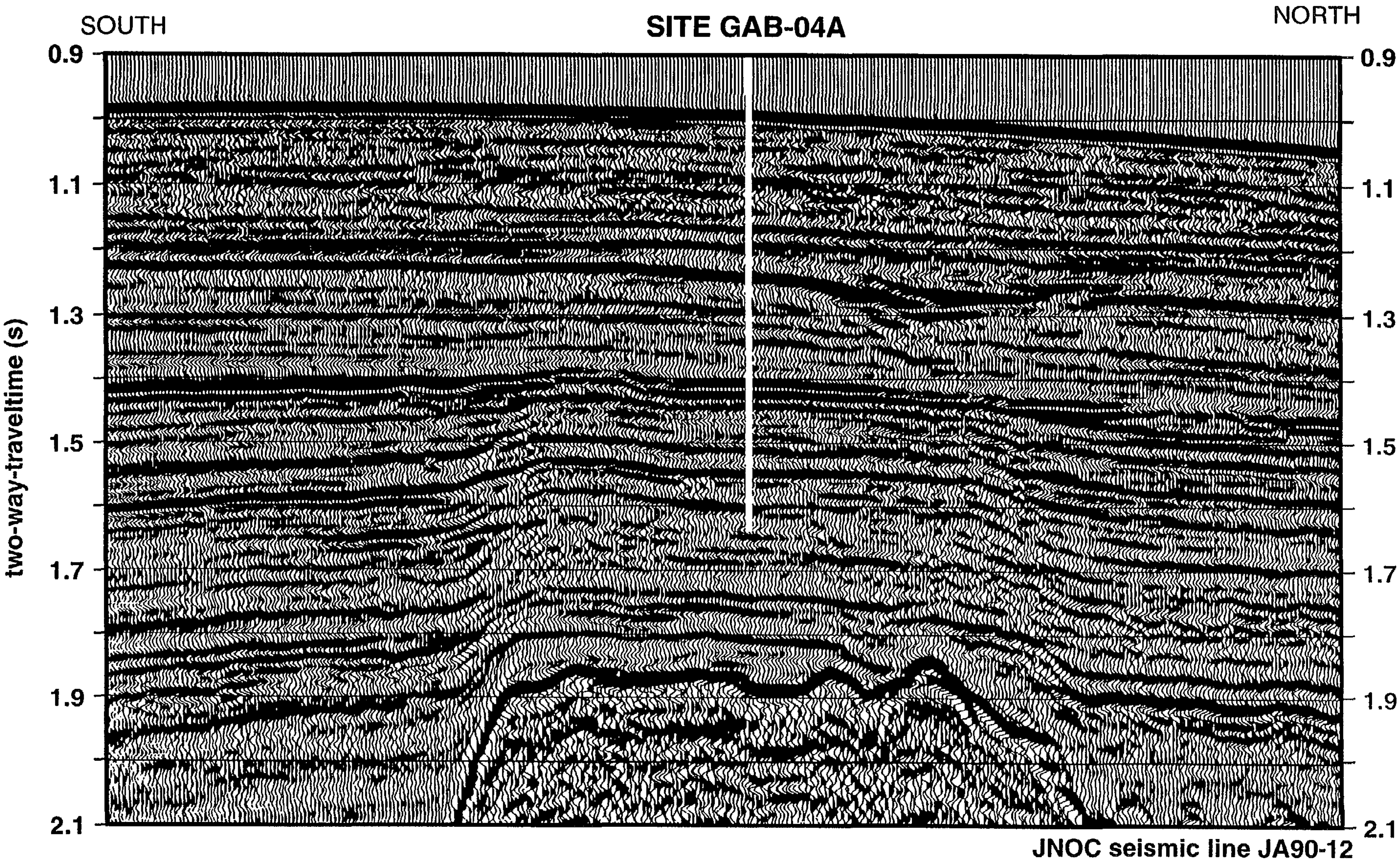
Other Remarks: Target is at crossing of seismic lines JA90-27; cdp 3000 (SP 1541) and JA90-12; cdp 27481 (SP 13781)

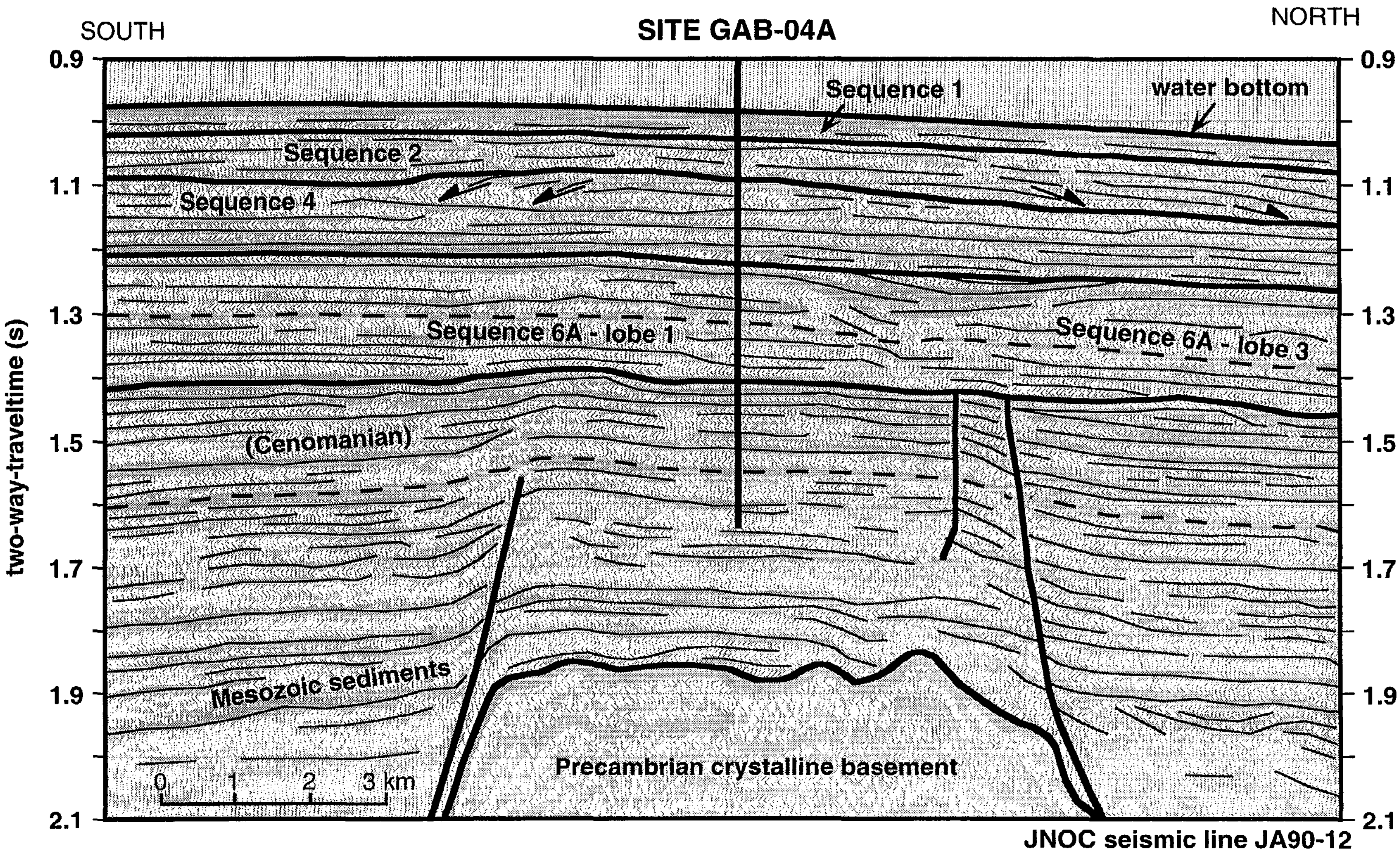
Contact Proponents:	Name/Address	Phone/FAX/Email
	Dr D.A. Feary, AGSO, Dept. Geology & Geophys., University of Sydney, Sydney 2006, AUSTRALIA	Phone: 61-2-351-2918; Fax: 61-2-351-0184 e-mail: dfeary@es.su.oz.au
	Dr N.P James, Department of Geological Sciences, Kingston, Ontario K7L 3N6, CANADA	Phone: 1-613-545-6170; Fax: 1-613-545-6592 e-mail: james@geol.queensu.ca



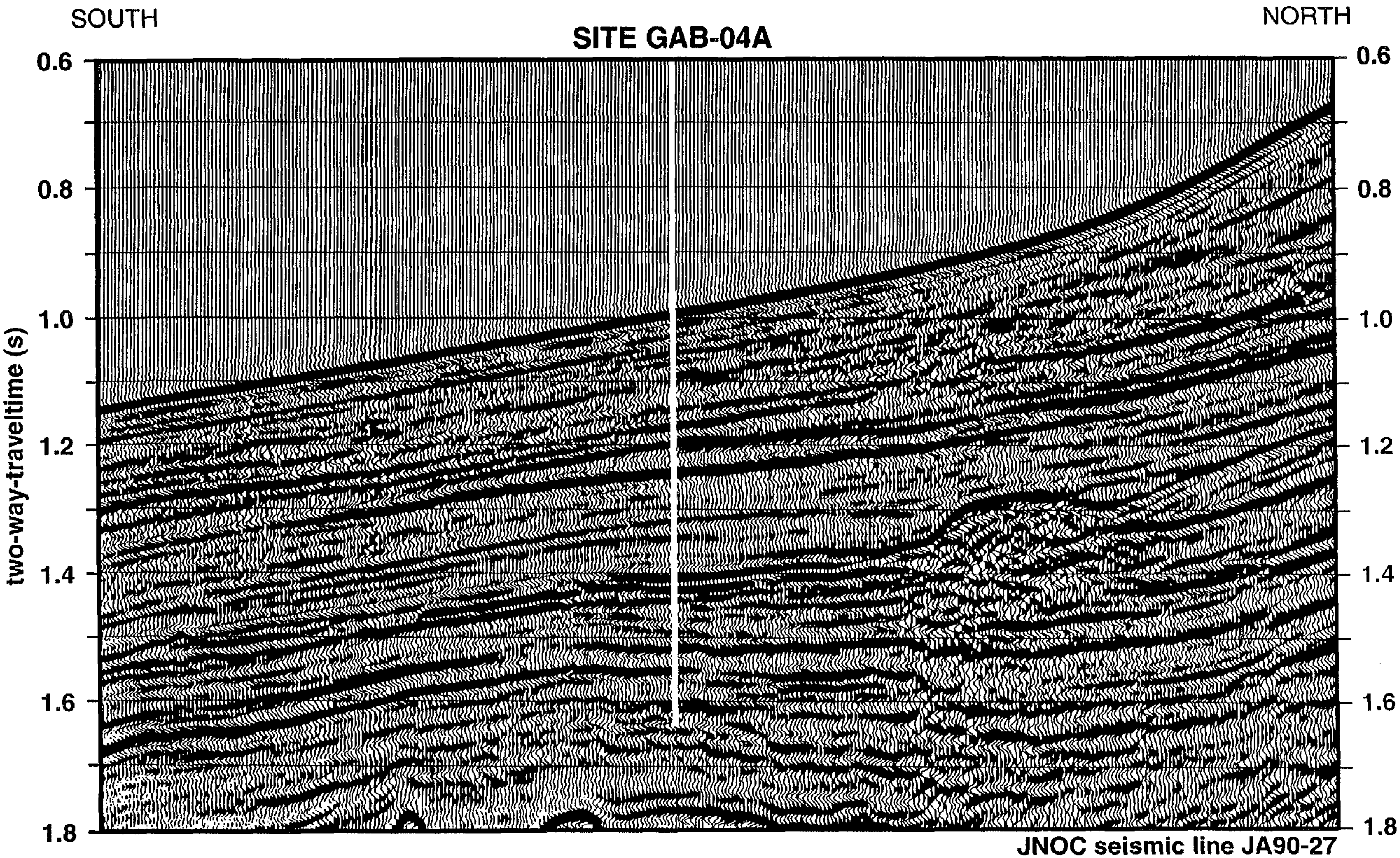


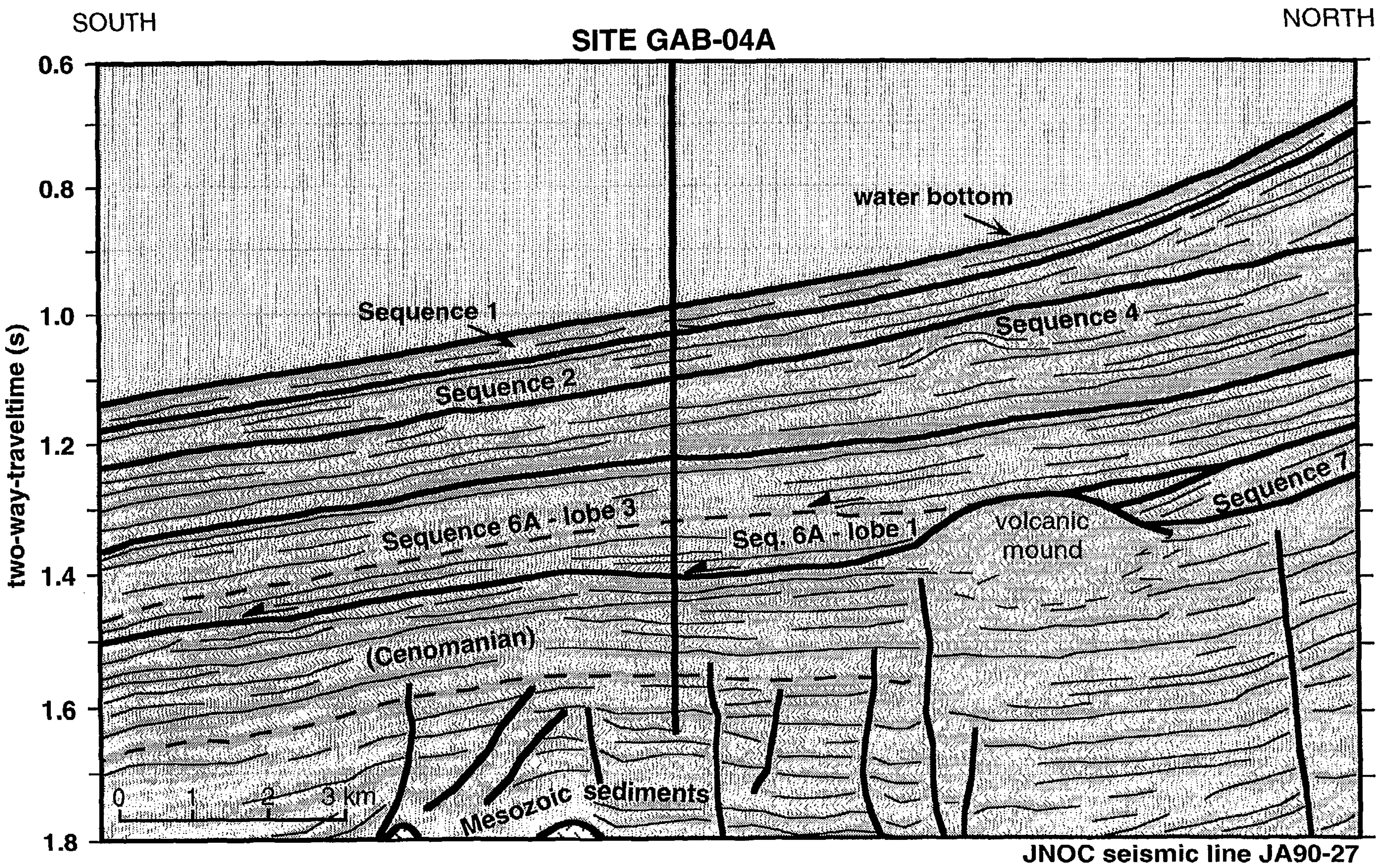
Velocity analyses for SP-13781 on seismic line JA90-12 and SP-1541 on seismic line JA90-27, corresponding to ODP Site GAB-04A. NMO (stacking) velocities are used to derive interval velocity profiles and time-depth curves.


SOUTH
SITE GAB-04A
NORTH
two-way-traveltime (s)
0.9
1.1
1.3
1.5
1.7
1.9
2.1
JNOC seismic line JA90-12



SOUTH
SITE GAB-04A
NORTH
0.9
1.1
1.3
1.5
1.7
1.9
2.1
two-way-traveltime (s)
Sequence 1
water bottom
Sequence 2
Sequence 4
Sequence 6A - lobe 1
Sequence 6A - lobe 3
(Cenomanian)
Mesozoic sediments
Precambrian crystalline basement
0 1 2 3 km
JNOC seismic line JA90-12


SOUTH
NORTH
SITE GAB-04A
two-way-traveltime (s)
0.6
0.8
1.0
1.2
1.4
1.6
1.8
JNOC seismic line JA90-27


SOUTH
NORTH
SITE GAB-04A
0.6
0.8
1.0
1.2
1.4
1.6
1.8
two-way-traveltime (s)
water bottom
Sequence 1
Sequence 2
Sequence 4
Sequence 6A - lobe 3
Seq. 6A - lobe 1
volcanic mound
Sequence 7
(Cenomanian)
Mesozoic sediments
0 1 2 3 km
JNOC seismic line JA90-27

4.3 SITES GAB-05B AND GAB-06B

Sites GAB-05B and GAB-06B are located to intersect distal (GAB-05B) and proximal (GAB-06B) parts of the Paleocene to middle Eocene progradational siliciclastic wedge. In addition, these sites will intersect a major portion of the overlying Neogene succession (seismic sequences 2 and 4). These sites were re-located following the 1995 panel reviews, to remove the risk of fluid contamination from volcanic intrusions, and also to intersect a substantial distal section through Sequence 3.

Principal Objective:

- to recover a detailed record of shelf-edge siliciclastic deposition to evaluate the sedimentary response to Paleogene sea-level fluctuations; and to evaluate the complex interaction between sea-level variation, accommodation space, and subsidence evident in stratal patterns.

Additional Objectives:

- to determine the characteristics of cool-water carbonate facies within the Neogene succession (Sequences 2 to 4).
- to determine paleoceanographic parameters within a shelf-edge setting in Sequences 2 to 4, to complement other components of the shelf-to-basin transect.
- to evaluate sea-level control on Neogene facies within an upper slope / shelf-edge setting (cf. Sites GAB-03A and GAB-04A).
- to evaluate the diagenetic history and processes within Neogene facies in an upper slope / shelf-edge setting.

ODP Site Summary Form 8/93 Fill out one form for each proposed site and attach to proposal

Title of Proposal:	Cenozoic cool-water carbonates of the Great Australian Bight.
Site-specific Objective(s) (List of general objectives must be inc. in proposal)	- penetrate upper slope Neogene succession - penetrate thick, youngest part of earliest Cenozoic sequence - siliciclastic progradational wedge to determine sealevel / sediment supply / subsidence controls on deposition

	Proposed Site	Alternate Site
Site Name:	Great Australian Bight-5 (GAB-05B)	
Area:	upper slope-Eucla Shelf, Great Australian Bight	
Lat./Long.:	33° 25' 12.4"S 127° 36' 06.7"E	
Water Depth:	482 m	
Sed. Thickness:	2680 msec TWT; ≈3910 m	
Total penetration:	612 msec TWT; ≈620 m	

	Sediments	Basement
Penetration:	612 msec TWT; ≈620 m	Nil
Lithology(ies):	380 m variably cemented grainstone and wackestone; 240 m lithified sandstone and shale	Precambrian granodiorite / granitic gneiss
Coring (check):	1-2√-3-**APC√** VPC* **XCB√** MDCB PCS **RCB√** DCS* Re-entry	
Downhole measurements	Full downhole logging suite	
Estimate days on site	5.5-6.5	

*Systems currently under development

Target(s) (see Proposal Submission Guidelines): A√ B√ C D E F G (check)

Site Survey Information (see Proposal Submission Guidelines for details and requirements):

		Check	Details of available data and data that is still to be collected
01	SCS deep penetration		
02	SCS High Resolution		
03	MCS and velocity	√	Airgun MCS available now; high-res. MCS to be collected during site surveys
04	Seismic grid		To be collected during site surveys
05	Refraction		
06	3.5 or 12 kHz		Both 3.5 and 12 kHz data to be collected during site surveys
07	Swath bathymetry		
08	H.-res side-looking sonar		
09	Photography/video		Bottom photographs to be collected during site surveys
10	Heat flow		
11	Magnetics/gravity	√	Additional magnetic and gravity data to be collected during site surveys
12	Coring		Gravity / piston coring to be undertaken during site surveys
13	Rock sampling		
14	Current meter		
15	Other		

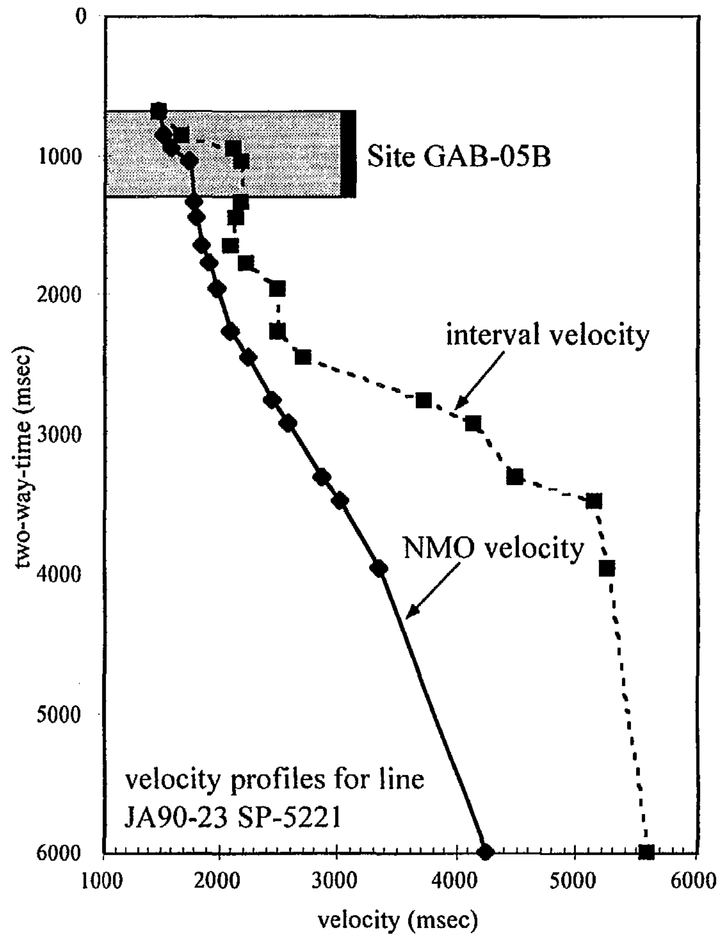
Weather, Ice, Surface Currents: Frequent storms at any time of year - however, summer (Dec-Feb) is optimum weather time

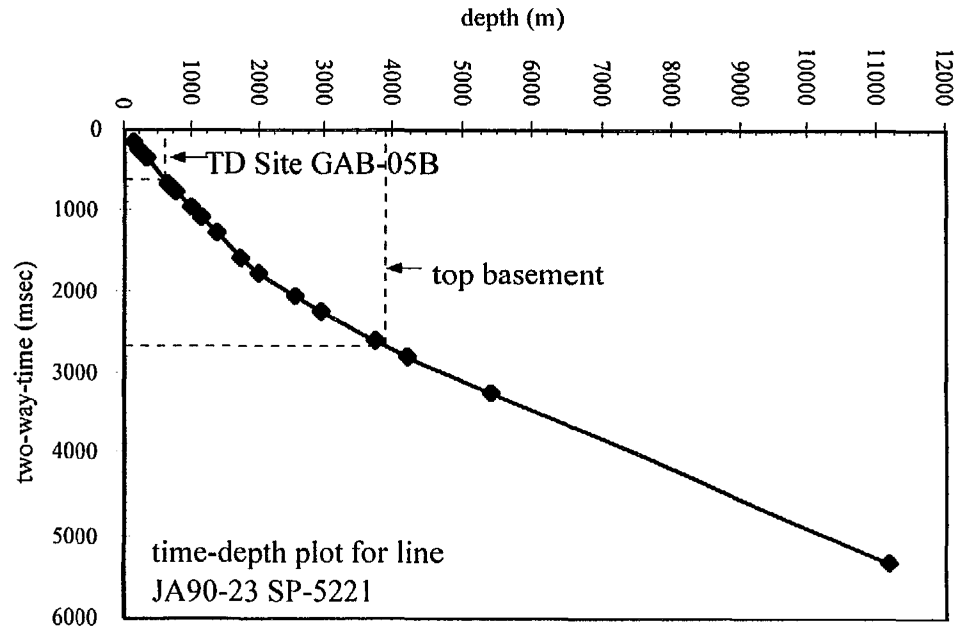
Seabed Hazards:

Territorial Jurisdiction: Australia (Western Australia)

Other Remarks: Target is on seismic line JA90-23; cdp 10297 (SP 5189)

	Name/Address	Phone/FAX/Email
Contact Proponents:	Dr D.A. Feary, AGSO, Dept. Geology & Geophys., University of Sydney, Sydney 2006, AUSTRALIA	Phone: 61-2-351-2918; Fax: 61-2-351-0184 e-mail: dfeary@es.su.oz.au
	Dr N.P James, Department of Geological Sciences, Kingston, Ontario K7L 3N6, CANADA	Phone: 1-613-545-6170; Fax: 1-613-545-6592 e-mail: james@geol.queensu.ca





Velocity analysis for SP-5221 on seismic line JA90-23, adjacent to ODP Site GAB-05B (SP-5189). NMO (stacking) velocities are used to derive an interval velocity profile and a time-depth curve.

ODP Site Summary Form 8/93

Fill out one form for each proposed site and attach to proposal

Title of Proposal:	Cenozoic cool-water carbonates of the Great Australian Bight.
Site-specific Objective(s) (List of general objectives must be inc. in proposal)	- penetrate upper slope / shelf-edge Neogene succession - penetrate earliest component of the Cenozoic succession; the proximal part of the sliciclastic progradational wedge to determine sealevel / sediment supply / subsidence controls on deposition

	Proposed Site	Alternate Site
Site Name:	Great Australian Bight-6 (GAB-06B)	
Area:	shelf edge - Eucla Shelf, Great Australian Bight	
Lat./Long.:	33° 18' 59.1"S 127° 36' 09.8"E	
Water Depth:	214 m	
Sed. Thickness:	1170 msec TWT; ≈1405 m	
Total penetration:	675 msec TWT; ≈725 m	

	Sediments	Basement
Penetration:	675 msec TWT; ≈725 m	Nil
Lithology(ies):	575 m variably cemented grainstone and wackestone; 150 m lithified sandstone and shale	Precambrian granodiorite / granitic gneiss
Coring (check):	1-**2√**-3-**APC√** VPC* **XCB√** MDCB PCS **RCB√** DCS* Re-entry	
Downhole measurements	Full downhole logging suite	
Estimate days on site	5.5-6.5	

*Systems currently under development

Target(s) (see Proposal Submission Guidelines): **A√** **B√** C D E F G (check)

Site Survey Information (see Proposal Submission Guidelines for details and requirements):

		Check	Details of available data and data that is still to be collected
01	SCS deep penetration		
02	SCS High Resolution		
03	MCS and velocity	√	Airgun MCS available now; high-res. MCS to be collected during site surveys
04	Seismic grid		To be collected during site surveys (according to SWGHS guidelines)
05	Refraction		
06	3.5 or 12 kHz		Both 3.5 and 12 kHz data to be collected during site surveys
07	Swath bathymetry		
08	H.-res side-looking sonar		To be collected during site surveys (according to SWGHS guidelines)
09	Photography/video		Bottom photographs to be collected during site surveys
10	Heat flow		
11	Magnetics/gravity	√	Additional magnetic and gravity data to be collected during site surveys
12	Coring		Gravity / piston coring to be undertaken during site surveys
13	Rock sampling		
14	Current meter		
15	Other		

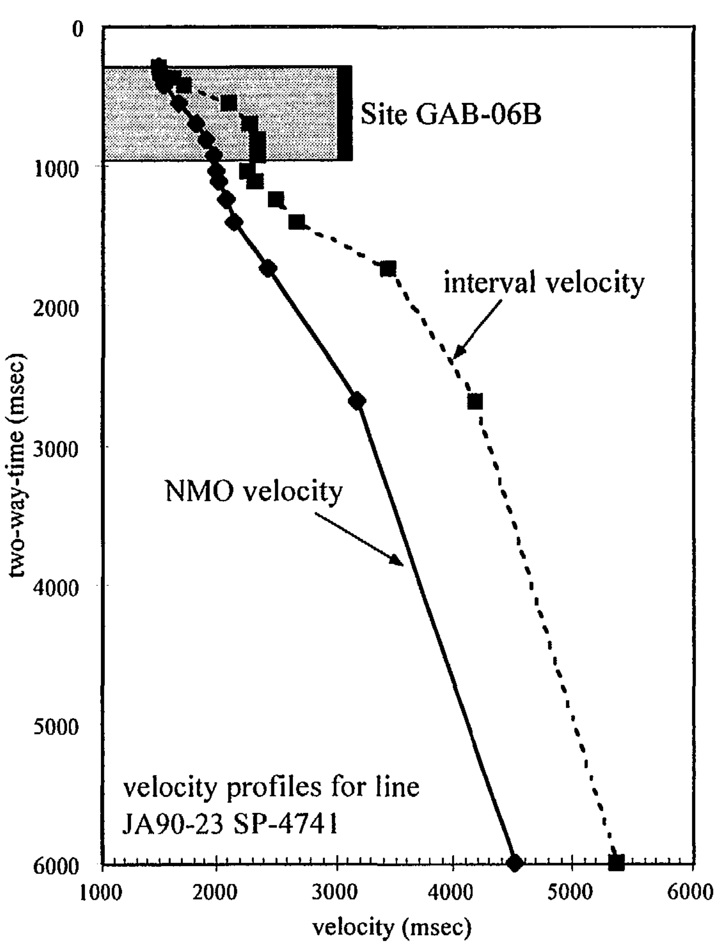
Weather, Ice, Surface Currents: Frequent storms at any time of year - however, summer (Dec-Feb) is optimum weather time

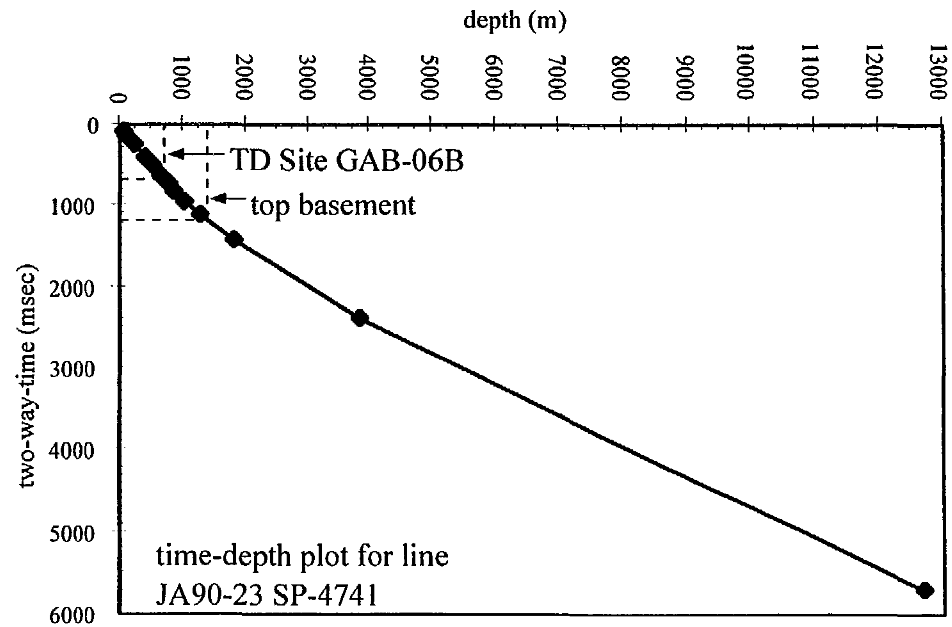
Seabed Hazards:

Territorial Jurisdiction: Australia (Western Australia)

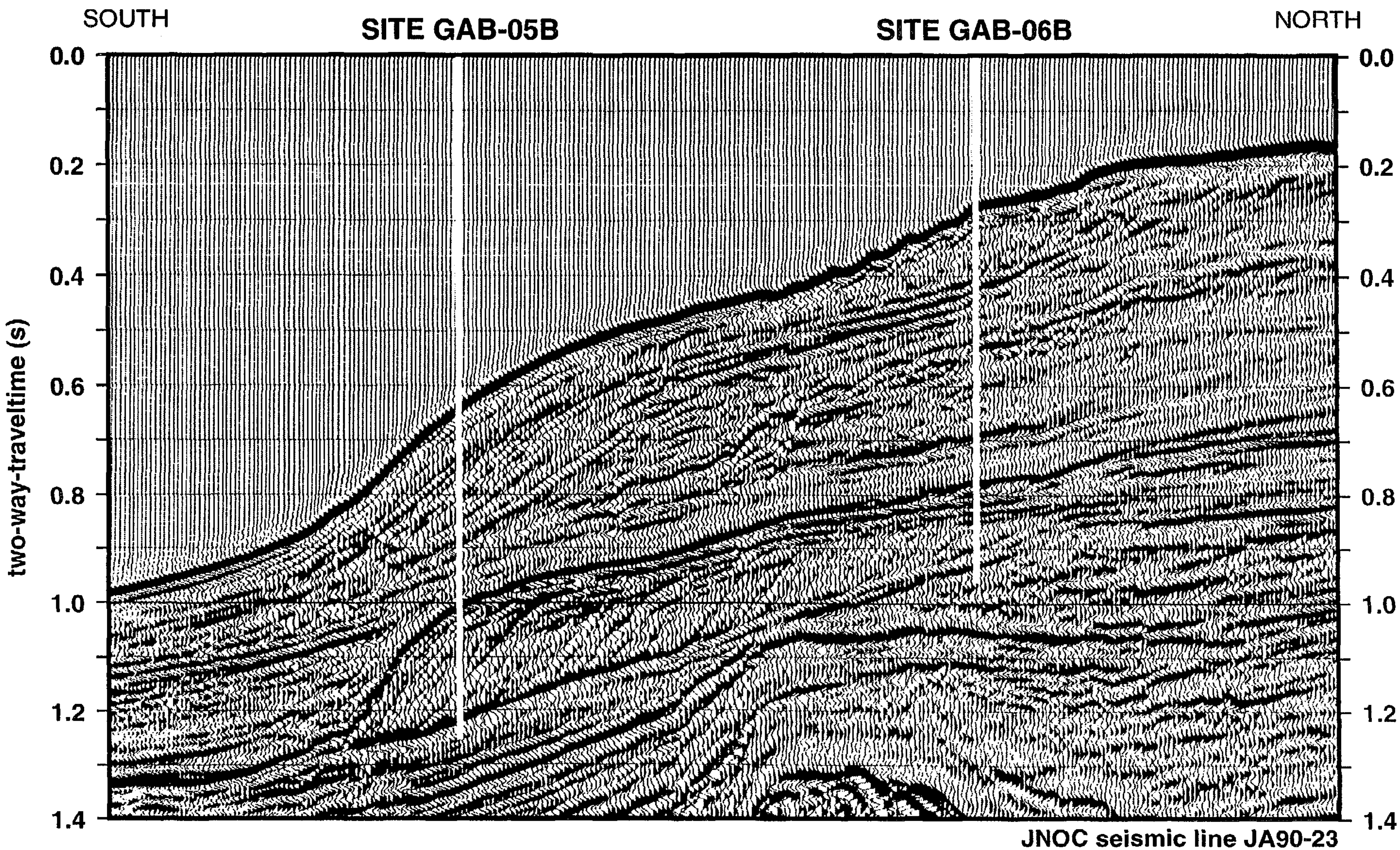
Other Remarks: Target is on seismic line JA90-23; cdp 9373 (SP 4727)

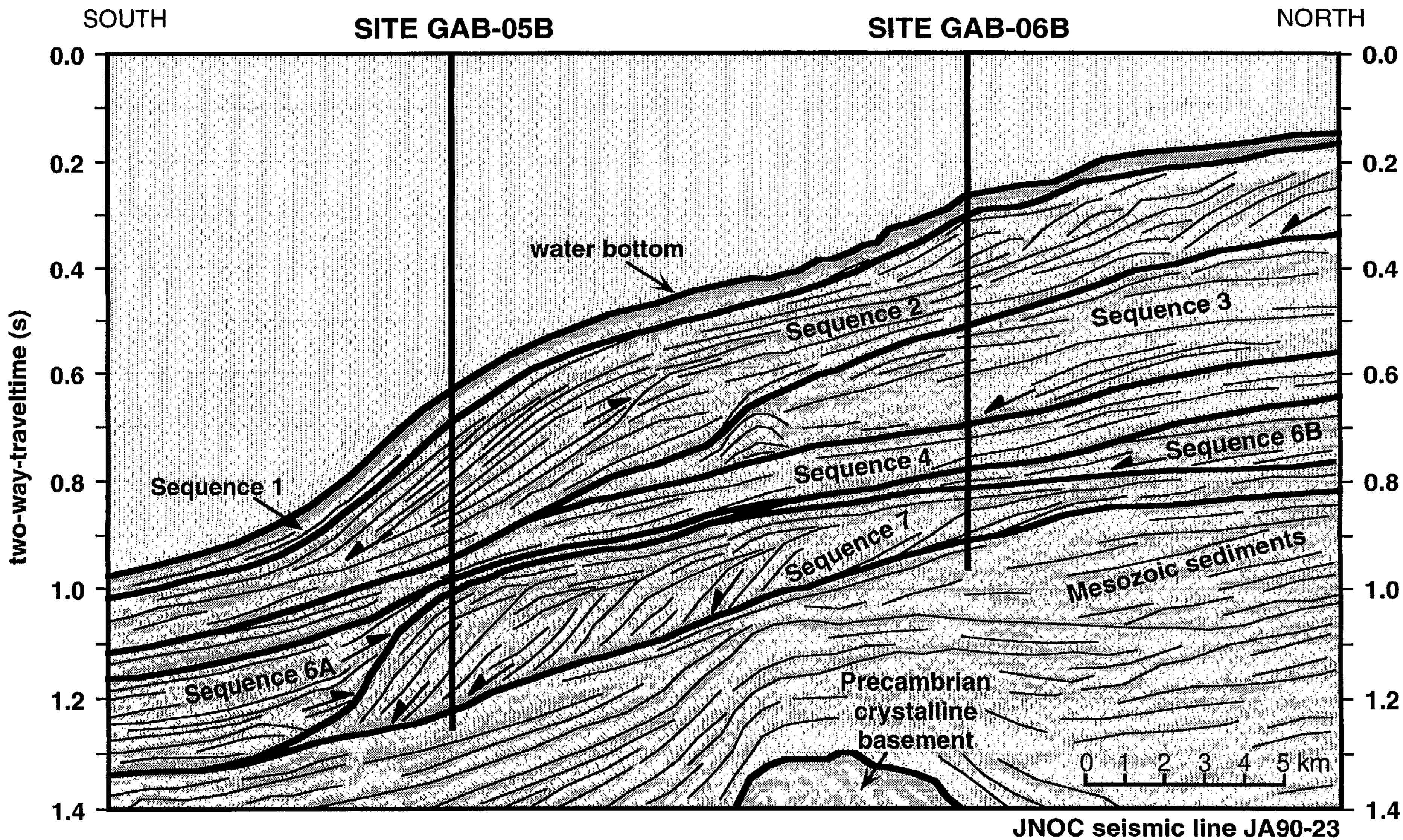
	Name/Address	Phone/FAX/Email
Contact Proponents:	Dr D.A. Feary, AGSO, Dept. Geology & Geophys., University of Sydney, Sydney 2006, AUSTRALIA	Phone: 61-2-351-2918; Fax: 61-2-351-0184 e-mail: dfeary@es.su.oz.au
	Dr N.P James, Department of Geological Sciences, Kingston, Ontario K7L 3N6, CANADA	Phone: 1-613-545-6170; Fax: 1-613-545-6592 e-mail: james@geol.queensu.ca





Velocity analysis for SP-4741 on seismic line JA90-23, adjacent to ODP Site GAB-06B (SP-4727). NMO (stacking) velocities are used to derive an interval velocity profile and a time-depth curve.


SOUTH
SITE GAB-05B
SITE GAB-06B
NORTH
two-way-traveltime (s)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
JNOC seismic line JA90-23


SOUTH
SITE GAB-05B
SITE GAB-06B
NORTH
two-way-traveltime (s)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
water bottom
Sequence 1
Sequence 2
Sequence 3
Sequence 4
Sequence 6A
Sequence 6B
Sequence 7
Mesozoic sediments
Precambrian crystalline basement
0 1 2 3 4 5 km
JNOC seismic line JA90-23

4.4 SITES GAB-07A TO GAB-09A

Sites GAB-07A, GAB-08A, and GAB-09A will intersect a spectacular set of late Neogene (?Plio-Pleistocene) clinoforms underlying the present-day shelf edge. Site GAB-07A will intersect the lowest, more condensed portion of the clinoform sequence, but will also have the best record of the youngest clinoforms; Site GAB-08A will intersect a ?Pleistocene-Holocene biogenic mound immediately below the sea-floor, together with the best record of the middle part of the clinoform sequence; and Site GAB-09A will intersect a buried biogenic mound originally formed immediately below the paleoshelf edge, together with the best record of the oldest part of the clinoform sequence.

Principal Objective:

▶ to collect detailed, high resolution profiles through a late Neogene succession deposited within a high-energy, cool-water carbonate environment in order to determine the response of such a depositional system to Plio-Pleistocene sea-level fluctuations.

Additional Objectives:

▶ to obtain a high resolution record of late Neogene paleoceanographic variation within an upper slope to shelf-edge setting, as a component of the shelf-to-basin paleoceanographic transect.

▶ to evaluate the diagenetic history of calcitic sediments deposited within a high energy environment subject to wave 'pumping' (in the upper part of the clinoform succession), for comparison with calcitic sediments deposited below storm wave base (in the lower part of the clinoform succession).

Note: although Site GAB-09A is presently in 196 m water depth, site surveys are likely to enable identification of an equivalent site in 200+ m water depth, in which identical objectives can be addressed; alternatively, PPSP, ODPSP, and ODP-TAMU may approve this site at its present water depth.

ODP Site Summary Form8/93 Fill out one form for each proposed site and attach to proposal

Title of Proposal:	Cenozoic cool-water carbonates of the Great Australian Bight.
Site-specific Objective(s) (List of general objectives must be inc. in proposal)	- penetrate Neogene prograding shelf-edge succession to determine sealevel control on cool-water carbonate shelf-edge / upper slope deposition

	Proposed Site	Alternate Site
Site Name:	Great Australian Bight-7 (GAB-07A)	
Area:	upper slope-Eucla Shelf, Great Australian Bight	
Lat./Long.:	33° 21' 28.0"S 128° 28' 53.1"E	
Water Depth:	469 m	
Sed. Thickness:	1875 msec TWT; ≈2645 m	
Total penetration:	594 msec TWT; ≈615 m	

	Sediments	Basement
Penetration:	594 msec TWT; ≈615 m	Nil
Lithology(ies):	615 m variably cemented grainstone and wackestone	Precambrian granodiorite / granitic gneiss
Coring (check):	1-2√-3-**APC√** VPC* **XCB√** MDCB PCS RCB DCS* Re-entry	
Downhole measurements	Full downhole logging suite	
Estimate days on site	2.5-3	

*Systems currently under development

Target(s) (see Proposal Submission Guidelines): A√ B√ C D E F G (check)

Site Survey Information (see Proposal Submission Guidelines for details and requirements):

		Check	Details of available data and data that is still to be collected
01	SCS deep penetration		
02	SCS High Resolution		
03	MCS and velocity	√	Airgun MCS available now; high-res. MCS to be collected during site surveys
04	Seismic grid		To be collected during site surveys
05	Refraction		
06	3.5 or 12 kHz		Both 3.5 and 12 kHz data to be collected during site surveys
07	Swath bathymetry		
08	H.-res side-looking sonar		
09	Photography/video		Bottom photographs to be collected during site surveys
10	Heat flow		
11	Magnetics/gravity	√	Additional magnetic and gravity data to be collected during site surveys
12	Coring		Gravity / piston coring to be undertaken during site surveys
13	Rock sampling		
14	Current meter		
15	Other		

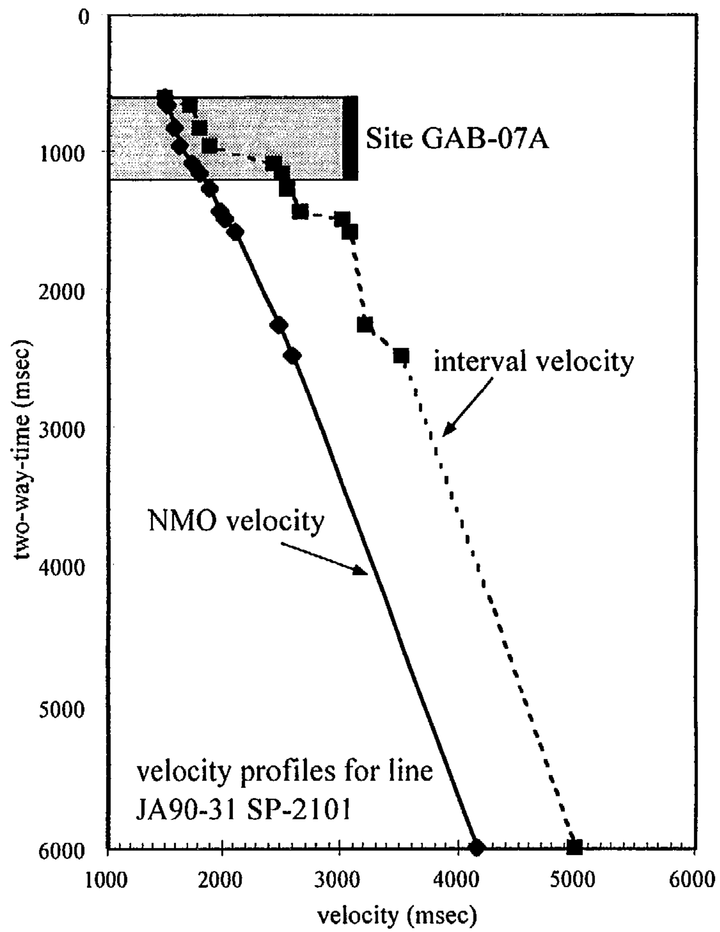
Weather, Ice, Surface Currents: Frequent storms at any time of year - however, summer (Dec-Feb) is optimum weather time

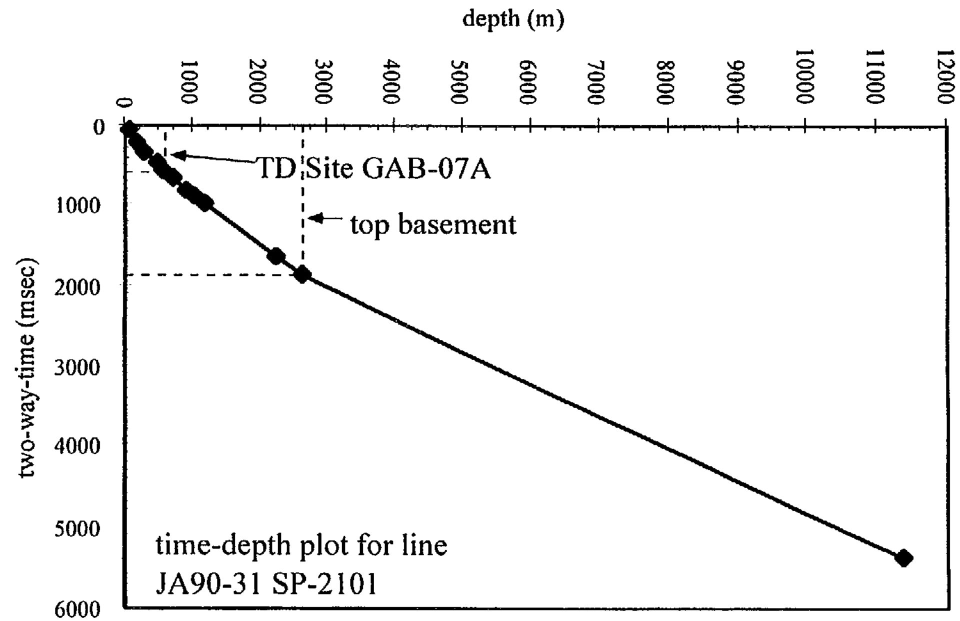
Seabed Hazards:

Territorial Jurisdiction: Australia (Western Australia)

Other Remarks: Target is on seismic line JA90-31; cdp 4096 (SP 2089)

	Name/Address	Phone/FAX/Email
Contact Proponents:	Dr D.A. Feary, AGSO, Dept. Geology & Geophys., University of Sydney, Sydney 2006, AUSTRALIA	Phone: 61-2-351-2918; Fax: 61-2-351-0184 e-mail: dfeary@es.su.oz.au
	Dr N.P James, Department of Geological Sciences, Kingston, Ontario K7L 3N6, CANADA	Phone: 1-613-545-6170; Fax: 1-613-545-6592 e-mail: james@geol.queensu.ca





Velocity analysis for SP-2101 on seismic line JA90-31, adjacent to ODP Site GAB-07A (SP-2089). NMO (stacking) velocities are used to derive an interval velocity profile and a time-depth curve.

ODP Site Summary Form 8/93

Fill out one form for each proposed site and attach to proposal

Title of Proposal:	Cenozoic cool-water carbonates of the Great Australian Bight.
Site-specific Objective(s) (List of general objectives must be inc. in proposal)	- penetrate Neogene prograding shelf-edge succession to determine sealevel control on cool-water carbonate shelf-edge / upper slope deposition

	Proposed Site	Alternate Site
Site Name:	Great Australian Bight-8 (GAB-08A)	
Area:	upper slope-Eucla Shelf, Great Australian Bight	
Lat./Long.:	33° 19' 34.4"S 128° 28' 52.6"E	
Water Depth:	315 m	
Sed. Thickness:	2045 msec TWT; ≈2880 m	
Total penetration:	640 msec TWT; ≈670 m	

	Sediments	Basement
Penetration:	640 msec TWT; ≈670 m	Nil
Lithology(ies):	670 m variably cemented grainstone and wackestone	Precambrian granodiorite / granitic gneiss
Coring (check):	1-<u>2√</u>-3-**<u>APC√</u>** VPC* **<u>XCB√</u>** MDCB PCS RCB DCS* Re-entry	
Downhole measurements	Full downhole logging suite	
Estimate days on site	2.5-3	

*Systems currently under development

Target(s) (see Proposal Submission Guidelines): <u>A√</u> <u>B√</u> C D E F G (check)

Site Survey Information (see Proposal Submission Guidelines for details and requirements):

		Check	Details of available data and data that is still to be collected
01	SCS deep penetration		
02	SCS High Resolution		
03	MCS and velocity	√	Airgun MCS available now; high-res. MCS to be collected during site surveys
04	Seismic grid		To be collected during site surveys
05	Refraction		
06	3.5 or 12 kHz		Both 3.5 and 12 kHz data to be collected during site surveys
07	Swath bathymetry		
08	H.-res side-looking sonar		
09	Photography/video		Bottom photographs to be collected during site surveys
10	Heat flow		
11	Magnetics/gravity	√	Additional magnetic and gravity data to be collected during site surveys
12	Coring		Gravity / piston coring to be undertaken during site surveys
13	Rock sampling		
14	Current meter		
15	Other		

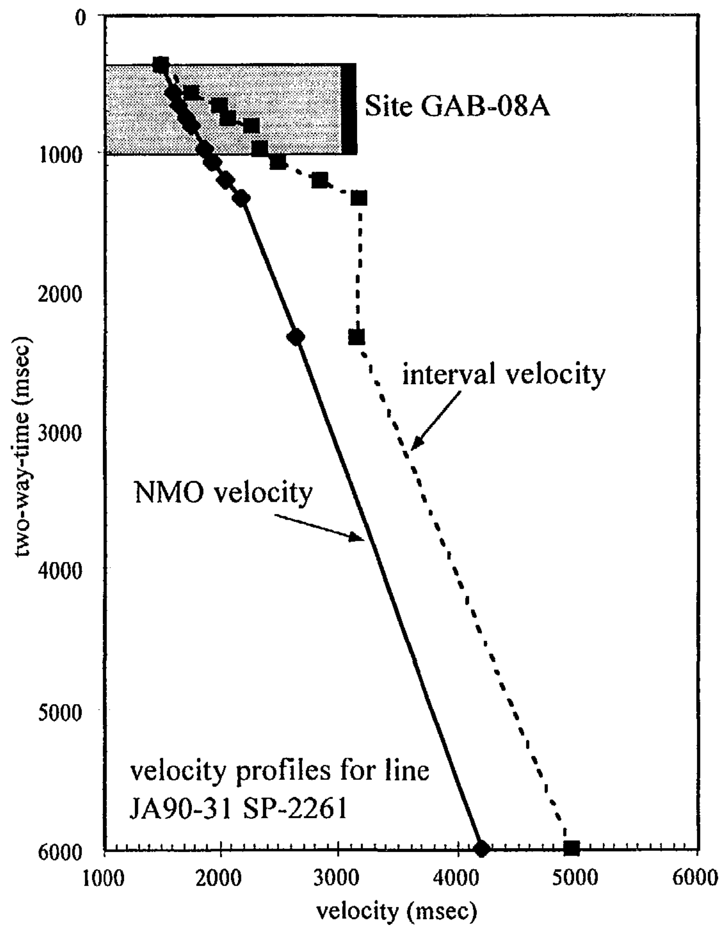
Weather, Ice, Surface Currents: Frequent storms at any time of year - however, summer (Dec-Feb) is optimum weather time

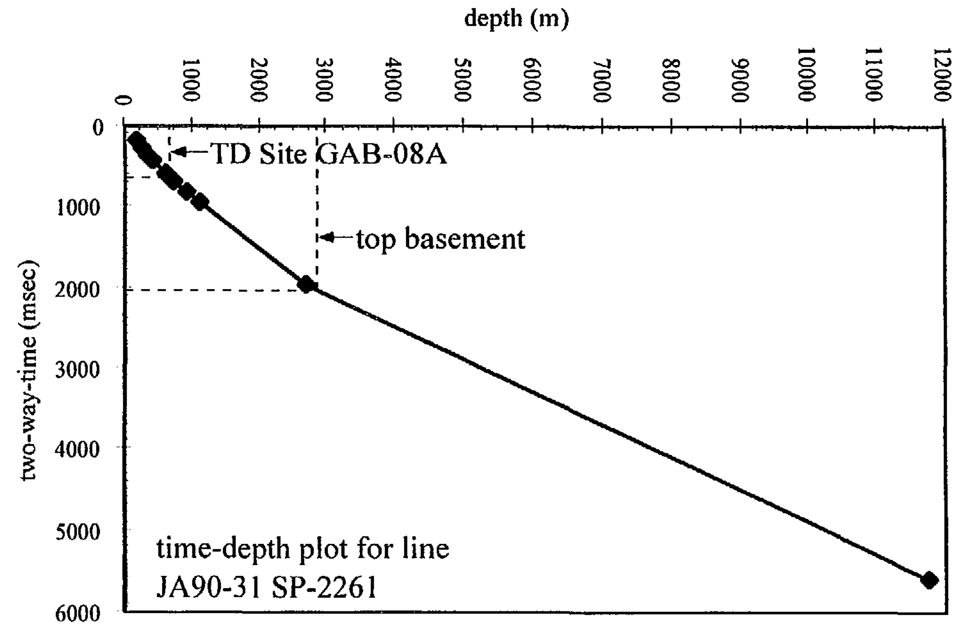
Seabed Hazards:

Territorial Jurisdiction: Australia (Western Australia)

Other Remarks: Target is on seismic line JA90-31; cdp 4376 (SP 2229)

	Name/Address	Phone/FAX/Email
Contact Proponents:	Dr D.A. Feary, AGSO, Dept. Geology & Geophys., University of Sydney, Sydney 2006, AUSTRALIA	Phone: 61-2-351-2918; Fax: 61-2-351-0184 e-mail: dfeary@es.su.oz.au
	Dr N.P James, Department of Geological Sciences, Kingston, Ontario K7L 3N6, CANADA	Phone: 1-613-545-6170; Fax: 1-613-545-6592 e-mail: james@geol.queensu.ca





Velocity analysis for SP-2261 on seismic line JA90-31, adjacent to ODP Site GAB-08A (SP-2229). NMO (stacking) velocities are used to derive an interval velocity profile and a time-depth curve.

ODP Site Summary Form 8/93 Fill out one form for each proposed site and attach to proposal

Title of Proposal:	Cenozoic cool-water carbonates of the Great Australian Bight.
Site-specific Objective(s) (List of general objectives must be inc. in proposal)	- penetrate Neogene prograding shelf-edge succession containing biogenic mounds to determine sealevel control on cool-water carbonate shelf-edge / upper slope deposition

	Proposed Site	Alternate Site
Site Name:	Great Australian Bight-9 (GAB-09A)	
Area:	shelf-edge - Eucla Shelf, Great Australian Bight	
Lat./Long.:	33° 17' 21.7"S 128° 28' 52.3"E	
Water Depth:	196 m	
Sed. Thickness:	1870 msec TWT; ≈2480 m	
Total penetration:	580 msec TWT; ≈630 m	

	Sediments	Basement
Penetration:	580 msec TWT; ≈630 m	Nil
Lithology(ies):	630 m variably cemented grainstone and wackestone	Precambrian granodiorite / granitic gneiss
Coring (check):	1-**2√**-3-**APC√** VPC* **XCB√** MDCB PCS RCB DCS* Re-entry	
Downhole measurements	Full downhole logging suite	
Estimate days on site	2.5-3	

*Systems currently under development

Target(s) (see Proposal Submission Guidelines): **A√** **B√** C D E F G (check)

Site Survey Information (see Proposal Submission Guidelines for details and requirements):

		Check	Details of available data and data that is still to be collected
01	SCS deep penetration		
02	SCS High Resolution		
03	MCS and velocity	√	Airgun MCS available now; high-res. MCS to be collected during site surveys
04	Seismic grid		To be collected during site surveys
05	Refraction		
06	3.5 or 12 kHz		Both 3.5 and 12 kHz data to be collected during site surveys
07	Swath bathymetry		
08	H.-res side-looking sonar		
09	Photography/video		Bottom photographs to be collected during site surveys
10	Heat flow		
11	Magnetics/gravity	√	Additional magnetic and gravity data to be collected during site surveys
12	Coring		Gravity / piston coring to be attempted during site surveys
13	Rock sampling		
14	Current meter		
15	Other		

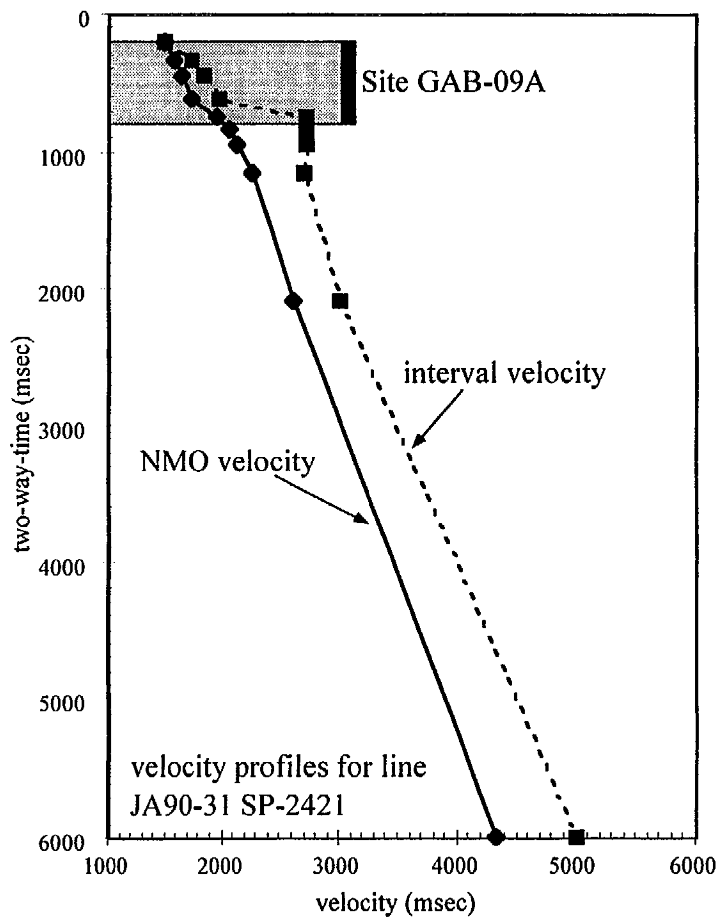
Weather, Ice, Surface Currents: Frequent storms at any time of year - however, summer (Dec-Feb) is optimum weather time

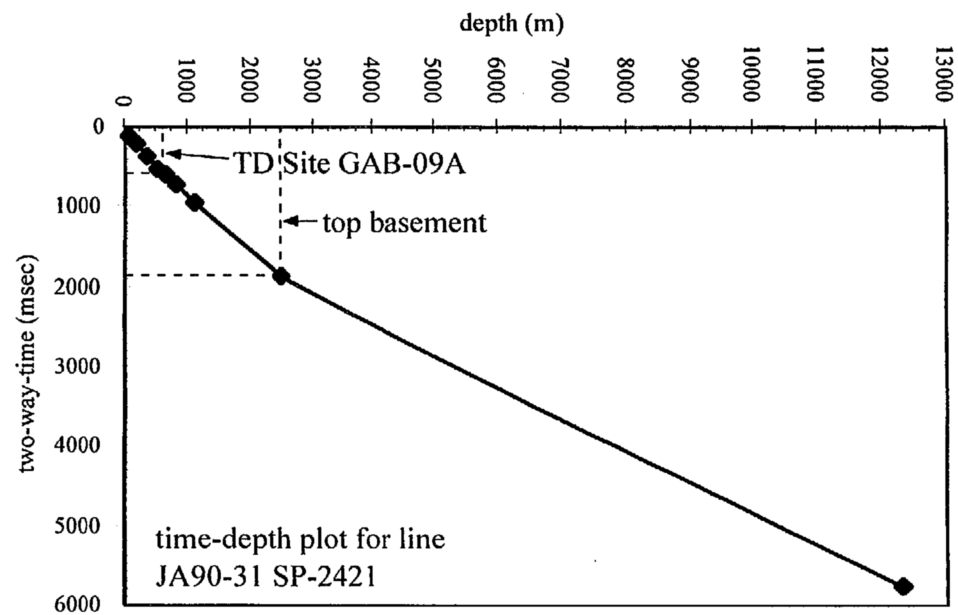
Seabed Hazards:

Territorial Jurisdiction: Australia (Western Australia)

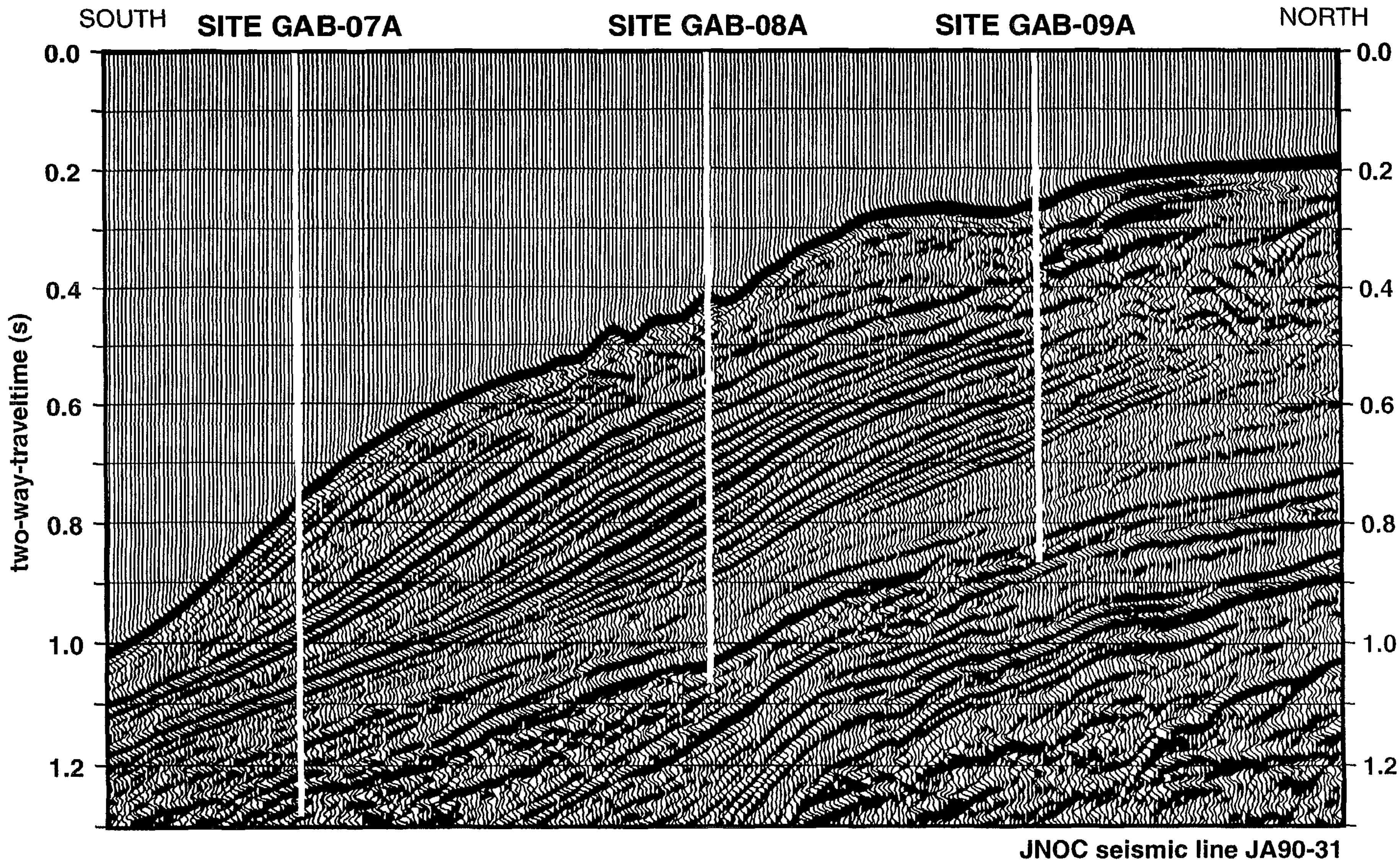
Other Remarks: Target is on seismic line JA90-31; cdp 4703 (SP 2391)

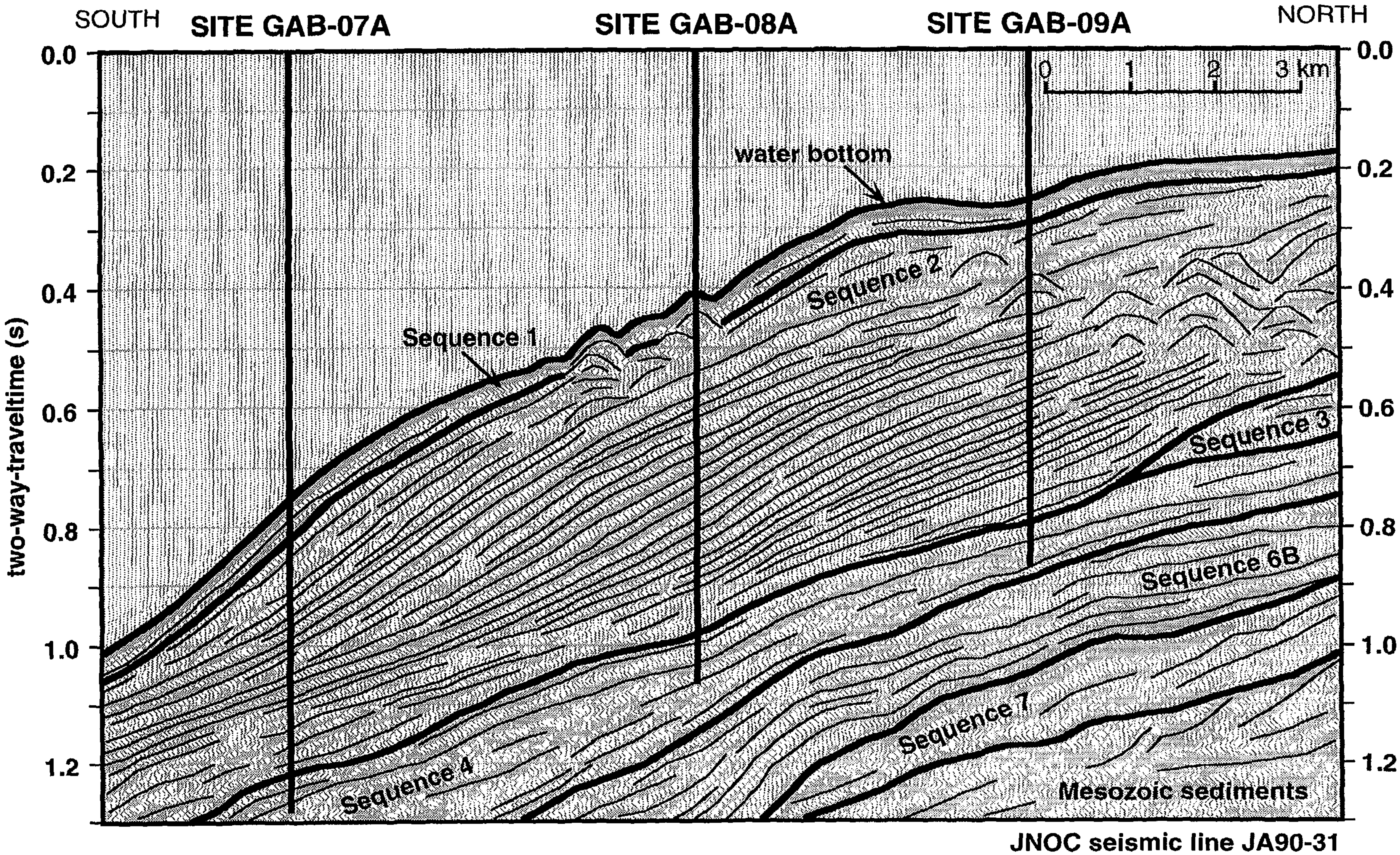
	Name/Address	Phone/FAX/Email
Contact Proponents:	Dr D.A. Feary, AGSO, Dept. Geology & Geophys., University of Sydney, Sydney 2006, AUSTRALIA	Phone: 61-2-351-2918; Fax: 61-2-351-0184 e-mail: dfeary@es.su.oz.au
	Dr N.P James, Department of Geological Sciences, Kingston, Ontario K7L 3N6, CANADA	Phone: 1-613-545-6170; Fax: 1-613-545-6592 e-mail: james@geol.queensu.ca





Velocity analysis for SP-2421 on seismic line JA90-31, adjacent to ODP Site GAB-09A (SP-2391). NMO (stacking) velocities are used to derive an interval velocity profile and a time-depth curve.


SOUTH
SITE GAB-07A
SITE GAB-08A
SITE GAB-09A
NORTH
two-way-traveltime (s)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
JNOC seismic line JA90-31


SOUTH
SITE GAB-07A
SITE GAB-08A
SITE GAB-09A
NORTH
0 1 2 3 km
water bottom
Sequence 1
Sequence 2
Sequence 3
Sequence 4
Sequence 6B
Sequence 7
Mesozoic sediments
two-way-traveltime (s)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
JNOC seismic line JA90-31

4.5 SITES GAB-10B AND GAB-11A

Site GAB-10B is intended to intersect the ?Late Miocene (Sequence 5) and Pliocene (Sequences 2 and 3) succession onlapping against the carbonate platform escarpment. Site GAB-11A is intended to drill through the Cenozoic section occurring beneath the present inner to middle shelf, and into underlying siliciclastic Mesozoic sediments. It is sited to intersect the succession of stacked late Early Oligocene to early Middle Miocene biogenic reefs, inferred to have formed in warm subtropical or cool tropical water conditions, that form the seaward margin of an extensive Eocene to Miocene carbonate platform. Site GAB-10B was moved slightly as a result of 1995 panel reviews, to intersect a more complete section through Sequence 5.

Principal Objectives:

- to evaluate the paleotemperature control on deposition of the "Little Barrier Reef" (Feary and James, 1995) rimmed carbonate platform margin, by contrasting paleotemperatures derived from both sites.
- to describe the carbonate facies deposited in both rimmed carbonate platform and cool-water inner shelf environments.
- to describe the faunal composition and community structure of the reefs which form the carbonate platform margin.
- to evaluate the effect of sealevel variation on depositional facies of the carbonate platform margin, and to compare this effect with better-known tropical carbonate platform rimmed margins.
- to similarly evaluate the diagenetic history of the carbonate platform margin reefs for comparison with tropical reefs.
- to assess the nature and timing of fluid flow events at the margin of a huge, low-gradient carbonate platform, particularly by examining pore water profiles and diagenetic effects from Site GAB-10B.

ODP Site Summary Form 8/93 Fill out one form for each proposed site and attach to proposal

Title of Proposal:	Cenozoic cool-water carbonates of the Great Australian Bight.
Site-specific Objective(s) (List of general objectives must be inc. in proposal)	- penetrate Miocene-?Pliocene inner shelf mound succession, and to determine facies and fluid circulation characteristics of the adjacent Eocene-Miocene carbonate platform.

	Proposed Site	Alternate Site
Site Name:	Great Australian Bight-10 (GAB-10B)	
Area:	inner Eucla Shelf, Great Australian Bight	
Lat./Long.:	32° 48' 19.3"S 127° 36' 27.1"E	
Water Depth:	52 m	
Sed. Thickness:	430 mS TWT; ≈530 m	
Total penetration:	380 mS TWT; ≈430 m	

	Sediments	Basement
Penetration:	380 mS TWT; ≈430 m	Nil
Lithology(ies):	420 m grainstone and wackestone; 10 m Mesozoic sandstone and shale	Precambrian granodiorite / granitic gneiss
Coring (check):	1-2√-3-**APC√** VPC* **XCB√** **MDCB√** PCS **RCB?** DCS* Re-entry	
Downhole measurements	Full downhole logging suite	
Estimate days on site	3.5-4	

*Systems currently under development

Target(s) (see Proposal Submission Guidelines): A **B√** C D E **F√** G (check)

Site Survey Information (see Proposal Submission Guidelines for details and requirements):

		Check	Details of available data and data that is still to be collected
01	SCS deep penetration		
02	SCS High Resolution		
03	MCS and velocity	√	Airgun MCS available now; high-res. MCS to be collected during site surveys
04	Seismic grid		To be collected during site surveys (according to SWGHS guidelines)
05	Refraction		
06	3.5 or 12 kHz		Both 3.5 and 12 kHz data to be collected during site surveys
07	Swath bathymetry		
08	H.-res side-looking sonar		
09	Photography/video		Bottom photographs to be collected during site surveys
10	Heat flow		
11	Magnetics/gravity	√	Additional magnetic and gravity data to be collected during site surveys
12	Coring		Vibrocoring to be attempted during site surveys
13	Rock sampling		
14	Current meter		
15	Other		

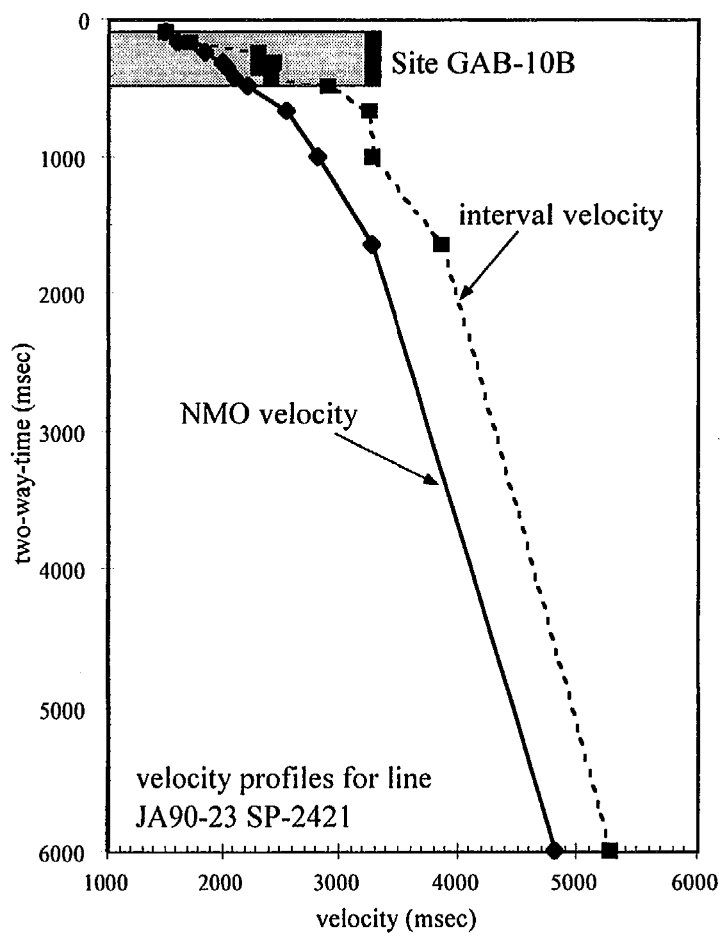
Weather, Ice, Surface Currents: Frequent storms at any time of year - however, summer (Dec-Feb) is optimum weather time

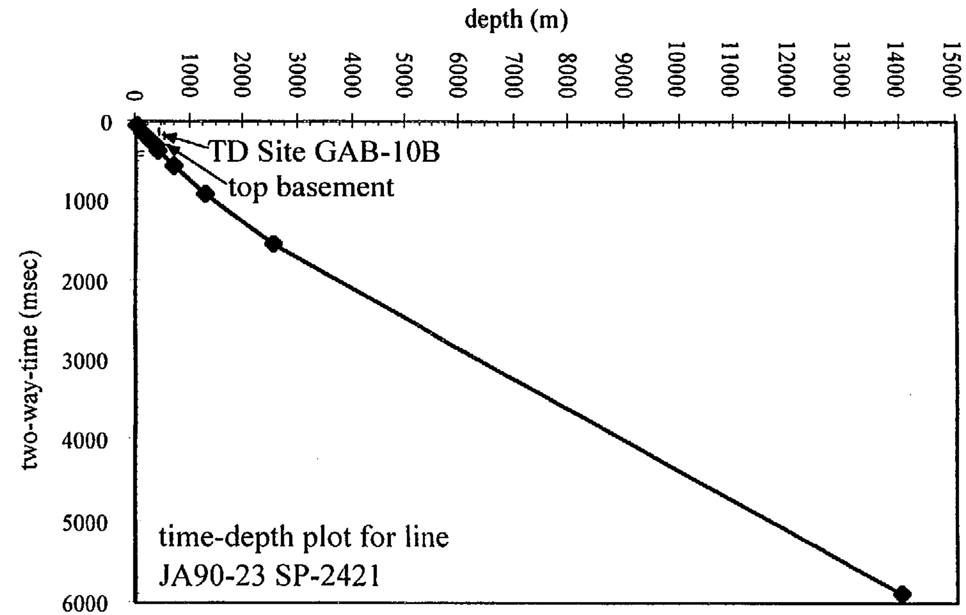
Seabed Hazards: Sea-floor is hard cemented limestone with negligible sediment cover; very shallow water

Territorial Jurisdiction: Australia (Western Australia)

Other Remarks: Target is on seismic line JA90-23; cdp 4825 (SP 2453)

	Name/Address	Phone/FAX/Email
Contact Proponents:	Dr D.A. Feary, AGSO, Dept. Geology & Geophys., University of Sydney, Sydney 2006, AUSTRALIA	Phone: 61-2-351-2918; Fax: 61-2-351-0184 e-mail: dfeary@es.su.oz.au
	Dr N.P James, Department of Geological Sciences, Kingston, Ontario K7L 3N6, CANADA	Phone: 1-613-545-6170; Fax: 1-613-545-6592 e-mail: james@geol.queensu.ca





Velocity analysis for SP-2421 on seismic line JA90-23, adjacent to ODP Site GAB-10B (SP-2453). NMO (stacking) velocities are used to derive an interval velocity profile and a time-depth curve.

ODP Site Summary Form8/93 Fill out one form for each proposed site and attach to proposal

Title of Proposal:	Cenozoic cool-water carbonates of the Great Australian Bight.
Site-specific Objective(s) (List of general objectives must be inc. in proposal)	- penetrate stacked Oligocene-early Middle Miocene biogenic reefs forming a rimmed carbonate platform margin to determine paleotemperature control on mid-latitude reef growth

	Proposed Site	Alternate Site
Site Name:	Great Australian Bight-11 (GAB-11A)	
Area:	middle Eucla Shelf, Great Australian Bight	
Lat./Long.:	32° 45' 32.8"S 127° 36' 28.5"E	
Water Depth:	51 m	
Sed. Thickness:	440 msec TWT; ≈535 m	
Total penetration:	392 msec TWT; ≈475 m	

	Sediments	Basement
Penetration:	392 mS TWT; ≈475 m	Nil
Lithology(ies):	465 m cemented grainstone and wackestone; 10 m Mesozoic sandstone and shale	Precambrian granodiorite / granitic gneiss
Coring (check):	1√-2-3-**APC√** VPC* **XCB√** **MDCB√** PCS **RCB√** DCS* Re-entry	
Downhole measurements	Full downhole logging suite	
Estimate days on site	4-5	

*Systems currently under development

Target(s) (see Proposal Submission Guidelines): A B√ C D E F√ G (check)

Site Survey Information (see Proposal Submission Guidelines for details and requirements):

		Check	Details of available data and data that is still to be collected
01	SCS deep penetration		
02	SCS High Resolution		
03	MCS and velocity	√	Airgun MCS available now; high-res. MCS to be collected during site surveys
04	Seismic grid		To be collected during site surveys (according to SWGHS guidelines)
05	Refraction		
06	3.5 or 12 kHz		Both 3.5 and 12 kHz data to be collected during site surveys
07	Swath bathymetry		
08	H.-res side-looking sonar		
09	Photography/video		Bottom photographs to be collected during site surveys
10	Heat flow		
11	Magnetics/gravity	√	Additional magnetic and gravity data to be collected during site surveys
12	Coring		Vibrocoring to be attempted during site surveys
13	Rock sampling		
14	Current meter		
15	Other		

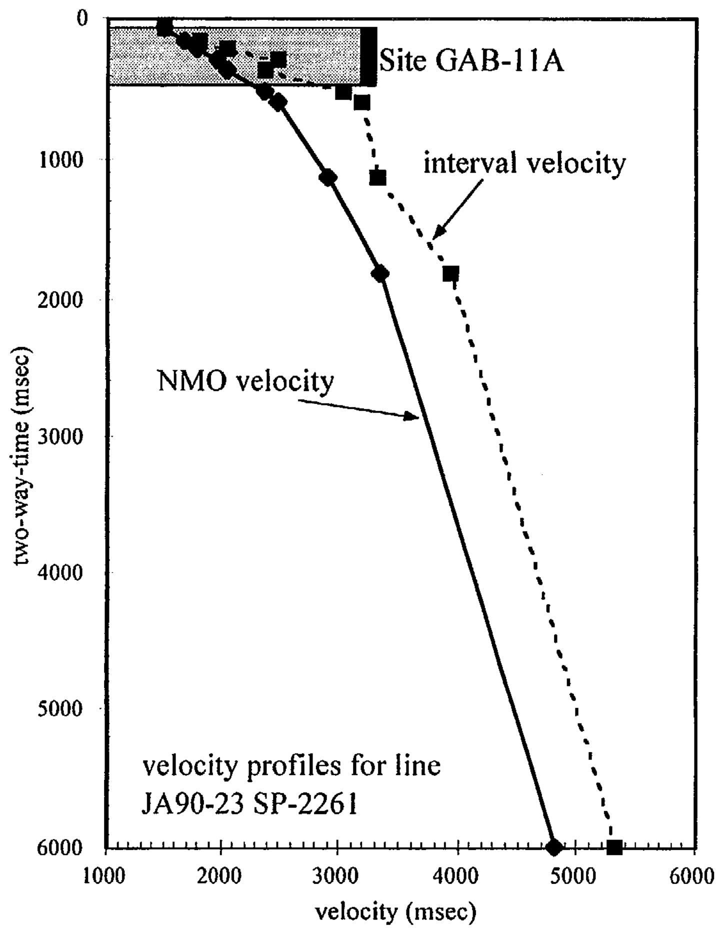
Weather, Ice, Surface Currents: Frequent storms at any time of year - however, summer (Dec-Feb) is optimum weather time

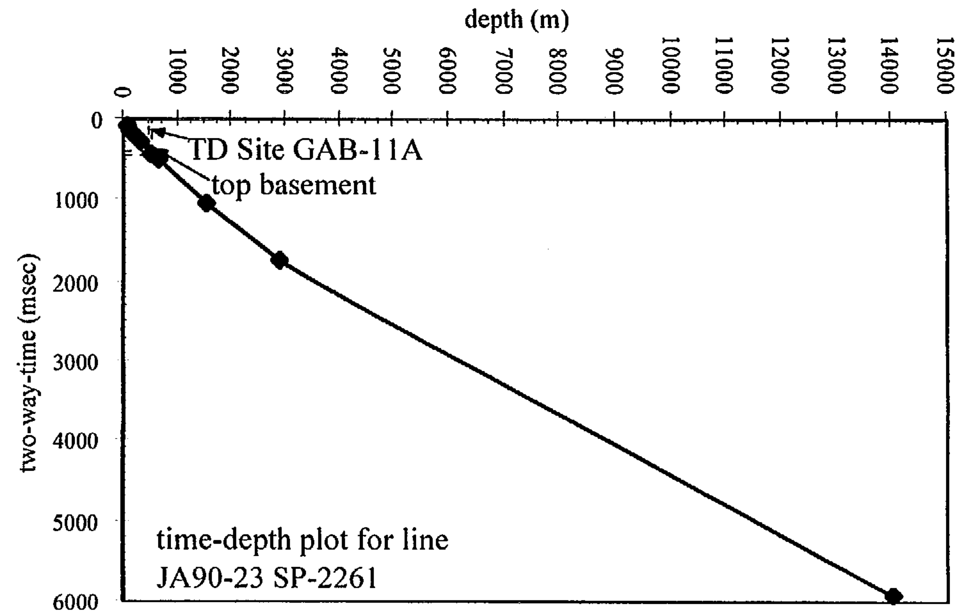
Seabed Hazards: Sea-floor is hard cemented limestone with negligible sediment cover; very shallow water

Territorial Jurisdiction: Australia (Western Australia)

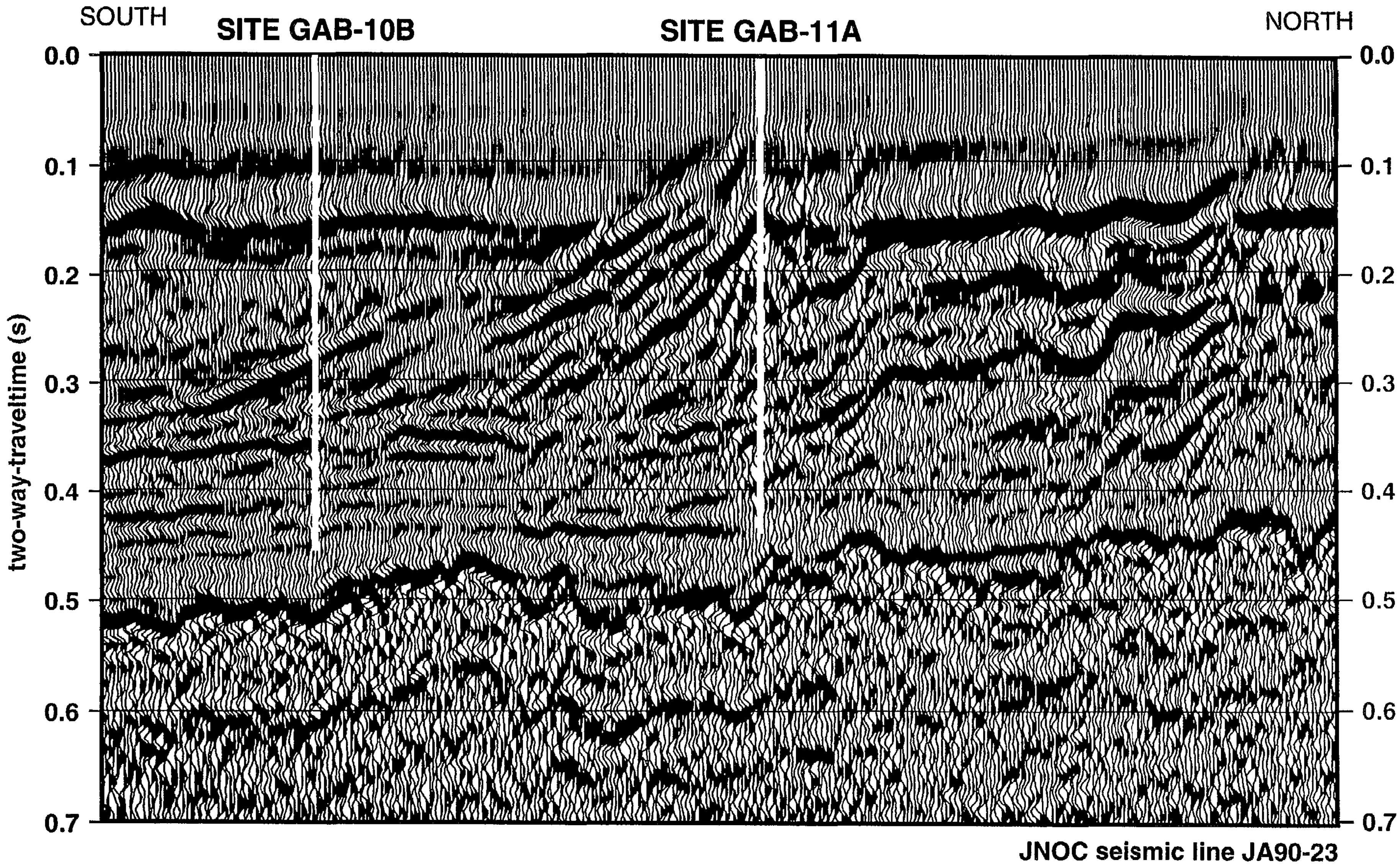
Other Remarks: Target is on seismic line JA90-23; cdp 4408 (SP 2245)

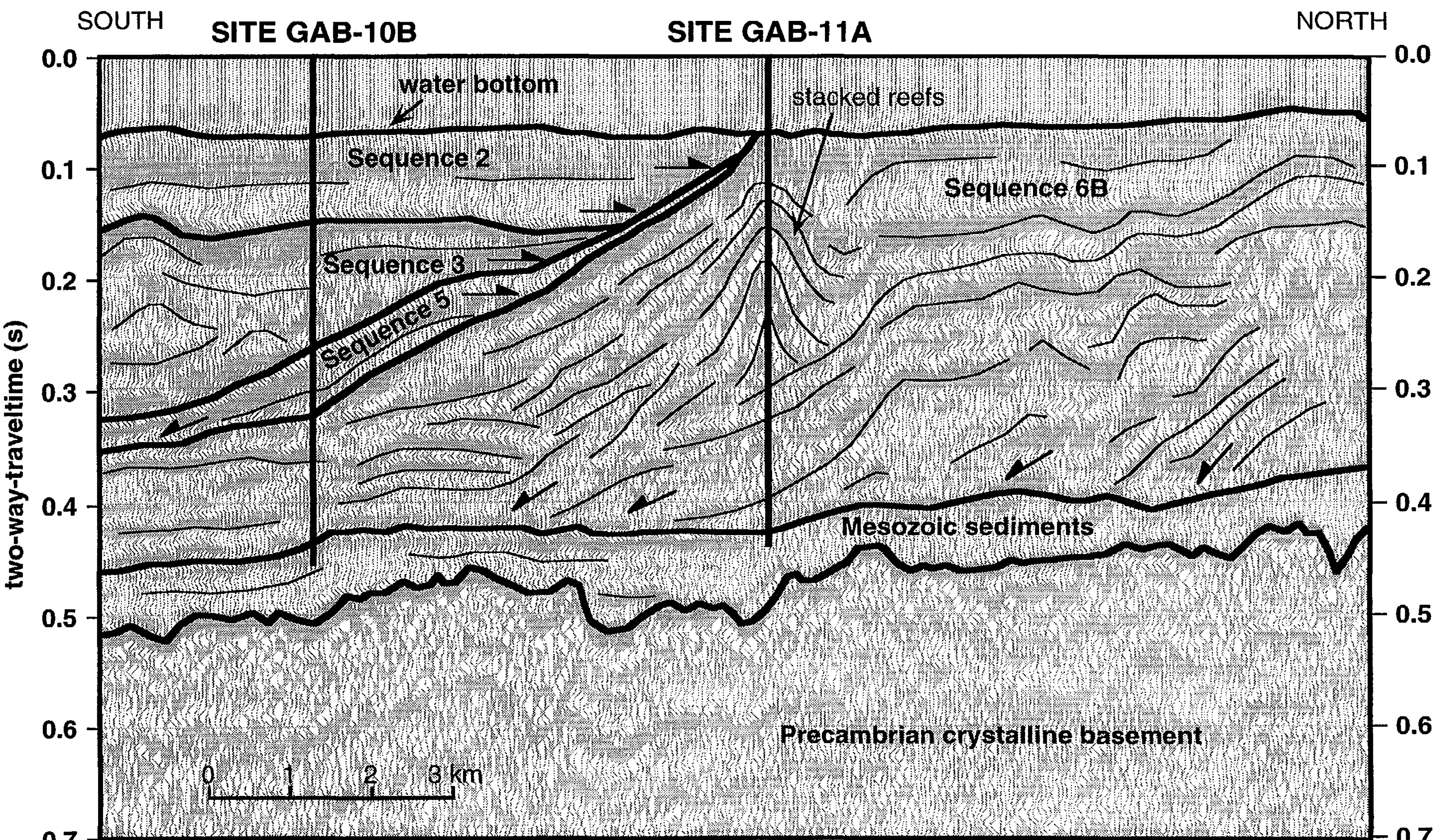
	Name/Address	Phone/FAX/Email
Contact Proponents:	Dr D.A. Feary, AGSO, Dept. Geology & Geophys., University of Sydney, Sydney 2006, AUSTRALIA	Phone: 61-2-351-2918; Fax: 61-2-351-0184 e-mail: dfeary@es.su.oz.au
	Dr N.P James, Department of Geological Sciences, Kingston, Ontario K7L 3N6, CANADA	Phone: 1-613-545-6170; Fax: 1-613-545-6592 e-mail: james@geol.queensu.ca





Velocity analysis for SP-2261 on seismic line JA90-23, adjacent to ODP Site GAB-11A (SP-2247). NMO (stacking) velocities are used to derive an interval velocity profile and a time-depth curve.


SOUTH
SITE GAB-10B
SITE GAB-11A
NORTH
two-way-traveltime (s)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
JNOC seismic line JA90-23



JNOC seismic line JA90-23

4.6 SITE GAB-12B

Site GAB-12B is intended to drill through the entire Cenozoic section beneath the present innermost shelf, through a thin underlying siliciclastic Mesozoic succession, and into Precambrian basement. It is sited to penetrate the interior of an extensive Eocene to Miocene carbonate platform, and to intersect Eocene to ?Oligocene biogenic mounds inferred to have formed in temperate or cool subtropical water conditions. This site was moved to its present location, at 50 m water depth, because the original site was too shallow.

Principal Objectives:

- ► to determine the paleotemperature control on carbonate ramp deposition, and to describe the carbonate facies deposited in both biohermal (mound) and biostromal portions of the early, ramp phase of the Eocene to Miocene carbonate platform.
- ► to describe the faunal composition and community structure of these biogenic mounds.
- ► to evaluate the diagenetic history of these mounds for comparison with warmer-water stacked reefs intersected at Site GAB-11, and also with tropical reefs from elsewhere.
- ► to evaluate the nature and timing of fluid flow events within a vast, low gradient carbonate platform.
- ► to determine the nature of acoustic (?Precambrian) basement and the overlying thin Mesozoic sequence.

ODP Site Summary Form8/93 Fill out one form for each proposed site and attach to proposal

Title of Proposal:	Cenozoic cool-water carbonates of the Great Australian Bight.
Site-specific Objective(s) (List of general objectives must be inc. in proposal)	- penetrate Eocene-?Oligocene inner shelf biogenic mound succession - penetrate thin Late Mesozoic non-marine succession and intersect Precambrian basement

	Proposed Site	Alternate Site
Site Name:	Great Australian Bight-12 (GAB-12B)	
Area:	inner Eucla Shelf, Great Australian Bight	
Lat./Long.:	32° 33' 41.3"S 128° 41' 33.6"E	
Water Depth:	50 m	
Sed. Thickness:	345 mS TWT; ≈540 m	
Total penetration:	340 mS TWT; ≈435 m	

	Sediments	Basement
Penetration:	331 mS TWT; ≈430 m	5 m
Lithology(ies):	360 m grainstone and wackestone; 70 m Mesozoic sandstone and shale	Precambrian granodiorite / granitic gneiss
Coring (check):	**1√**-2-3-**APC√** VPC* **XCB√** **MDCB√** PCS **RCB√** DCS* Re-entry	
Downhole measurements	Full downhole logging suite	
Estimate days on site	4-5	

*Systems currently under development

Target(s) (see Proposal Submission Guidelines): A **B√** C D E **F√** G (check)

Site Survey Information (see Proposal Submission Guidelines for details and requirements):

		Check	Details of available data and data that is still to be collected
01	SCS deep penetration		
02	SCS High Resolution		
03	MCS and velocity	√	Airgun MCS available now; high-res. MCS to be collected during site surveys
04	Seismic grid		To be collected during site surveys (according to SWGHS guidelines)
05	Refraction		
06	3.5 or 12 kHz		Both 3.5 and 12 kHz data to be collected during site surveys
07	Swath bathymetry		
08	H.-res side-looking sonar		
09	Photography/video		Bottom photographs to be collected during site surveys
10	Heat flow		
11	Magnetics/gravity	√	Additional magnetic and gravity data to be collected during site surveys
12	Coring		Vibrocoring to be attempted during site surveys
13	Rock sampling		
14	Current meter		
15	Other		

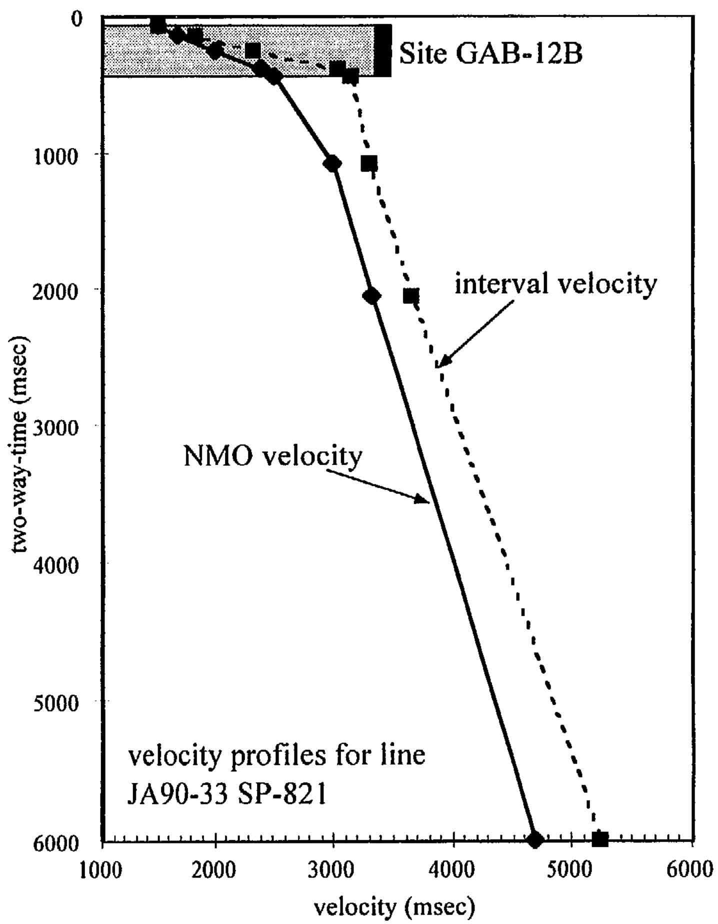
Weather, Ice, Surface Currents: Frequent storms at any time of year - however, summer (Dec-Feb) is optimum weather time

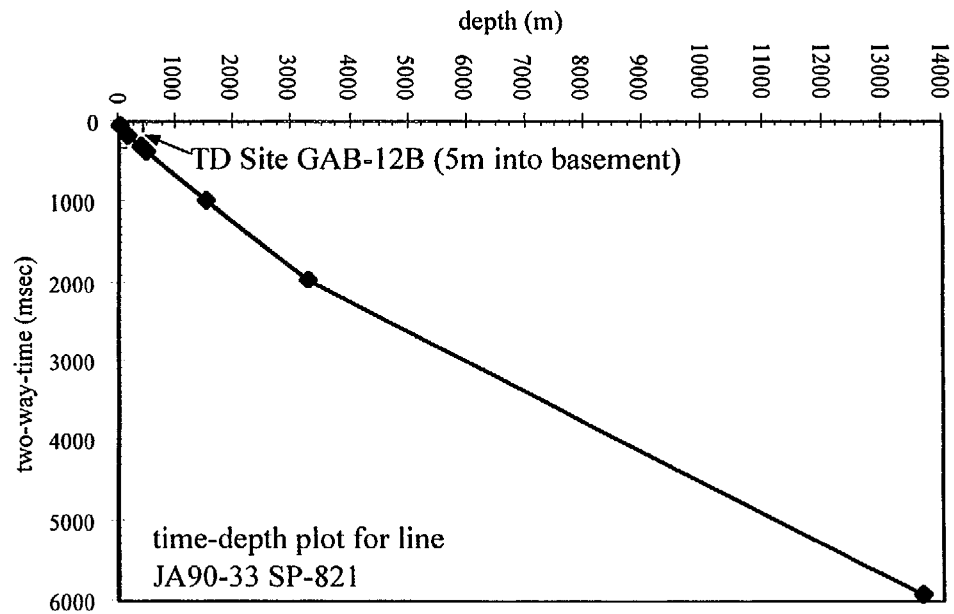
Seabed Hazards: Sea-floor is hard cemented limestone with negligible sediment cover; very shallow water

Territorial Jurisdiction: Australia (Western Australia)

Other Remarks: Target is on seismic line JA90-33; cdp 1617 (SP 849)

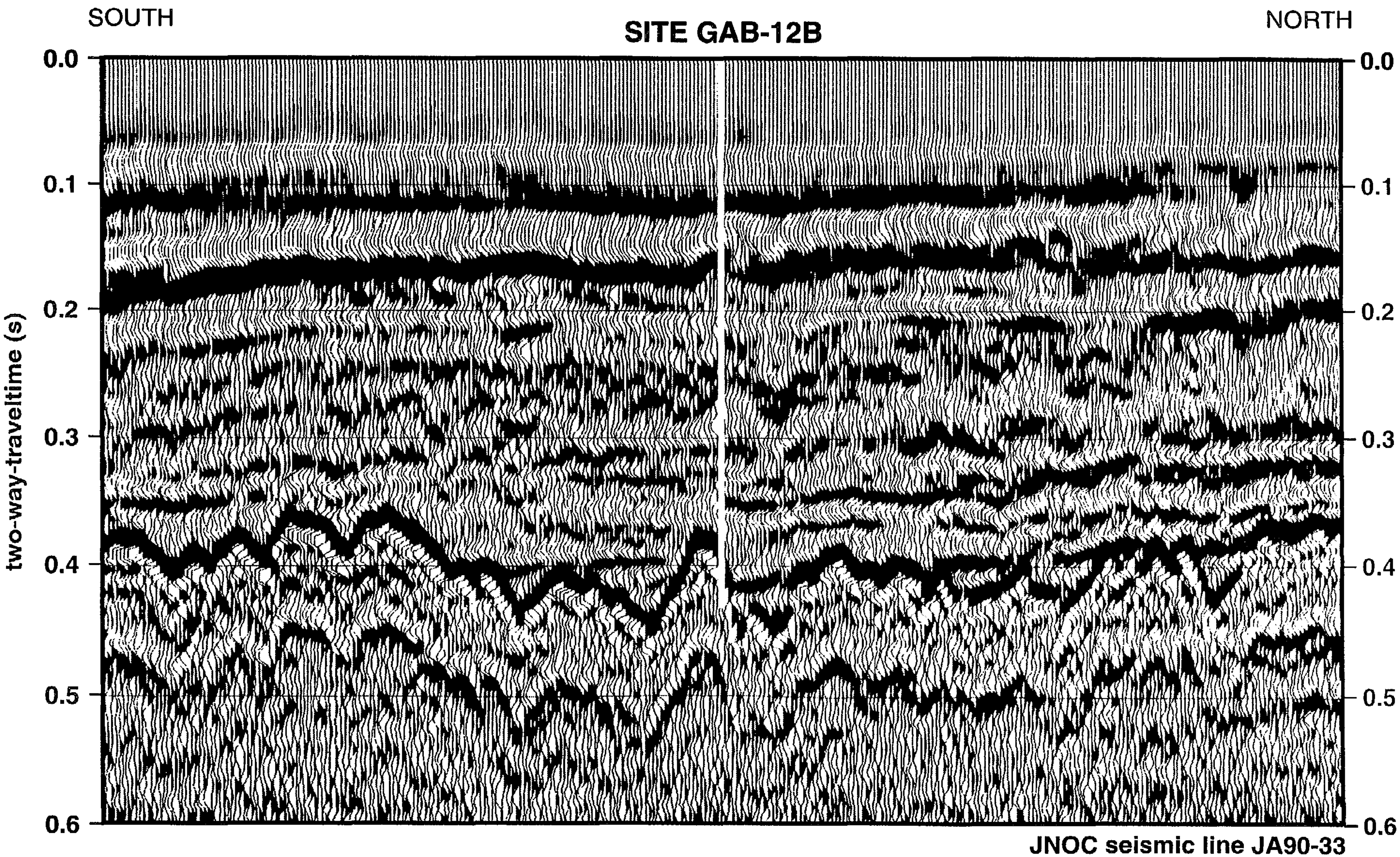
	Name/Address	Phone/FAX/Email
Contact Proponents:	Dr D.A. Feary, AGSO, Dept. Geology & Geophys., University of Sydney, Sydney 2006, AUSTRALIA	Phone: 61-2-351-2918; Fax: 61-2-351-0184 e-mail: dfeary@es.su.oz.au
	Dr N.P James, Department of Geological Sciences, Kingston, Ontario K7L 3N6, CANADA	Phone: 1-613-545-6170; Fax: 1-613-545-6592 e-mail: james@geol.queensu.ca

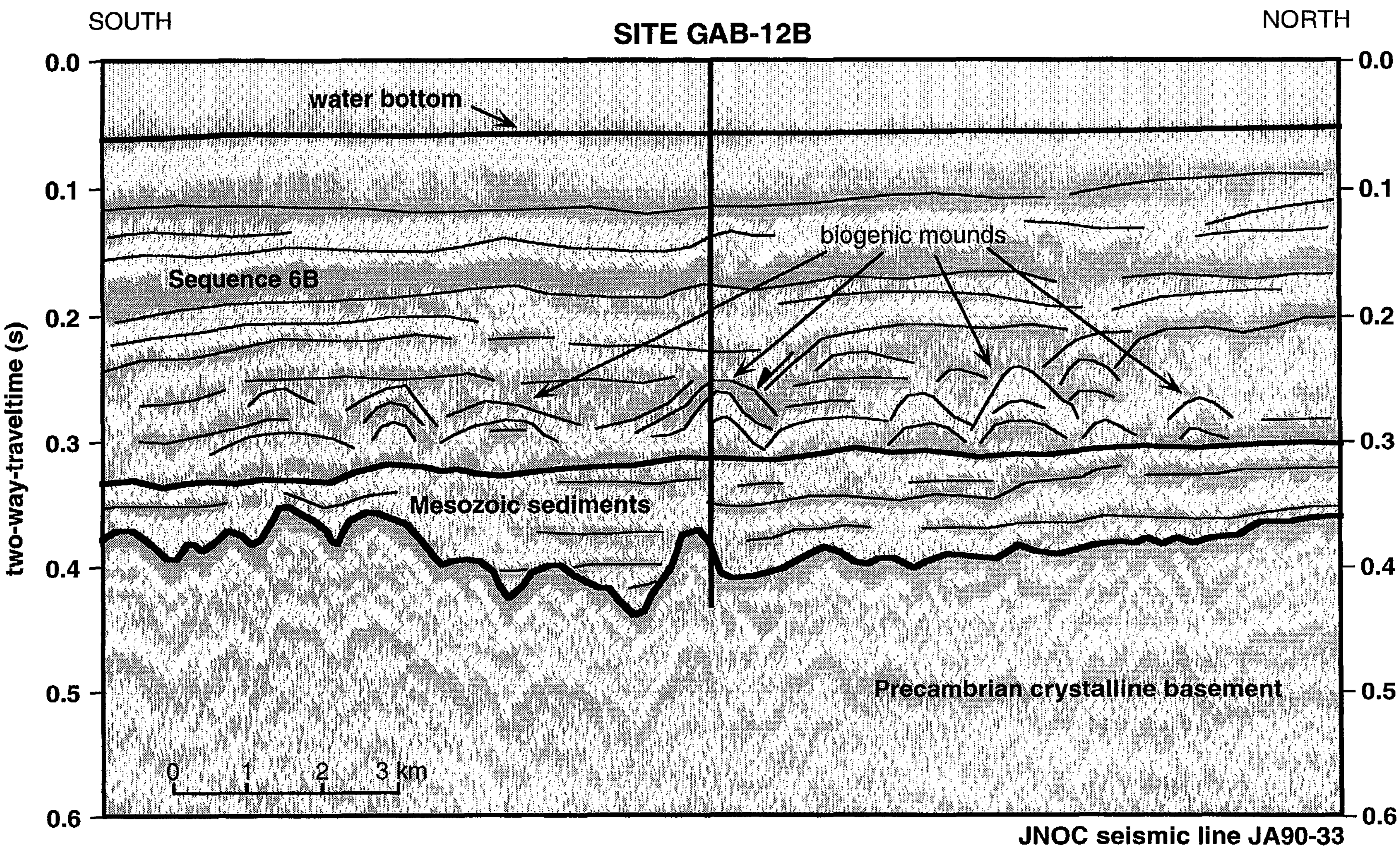




Velocity analysis for SP-821 on seismic line JA90-33, adjacent to ODP Site GAB-12B (SP-849). NMO (stacking) velocities are used to derive an interval velocity profile and a time-depth curve.

SITE GAB-12B


SOUTH
NORTH
two-way-traveltime (s)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
JNOC seismic line JA90-33


SOUTH
SITE GAB-12B
NORTH
0.0
0.1
0.2
0.3
0.4
0.5
0.6
two-way-traveltime (s)
water bottom
biogenic mounds
Sequence 6B
Mesozoic sediments
Precambrian crystalline basement
0 1 2 3 km
JNOC seismic line JA90-33

4. REFERENCES

Aharon, P., Socki, R.A., and Chan, L., 1987. Dolomitisation of atolls by seawater convection flow; test of a hypothesis at Nuie, south Pacific. *Journal of Geology,* 95: 187-203.

Aissaoui, D.M., Buigues, D., and Purser, B.H., 1986. Model of reef diagenesis: Mururoa Atoll, French Polynesia. *In* Schroeder, J.H., and Purser, B.H., (eds), *Reef Diagenesis,* Springer Verlag, Berlin.

Arai, K., Davies P.J., Konishi, K., and Maas, R., 1995. Temperate shelf carbonates, Torquay, Victoria. Cool & Cold-Water Carbonate Conference, Geelong, 14-19 Jan 95, Australasian Sedimentologists Specialist Group, Geological Society of Australia: 1-4.

Banner, J.L., and Hanson, G.N., 1990. Calculation of simultaneous isotopic and trace element variations during water/rock interaction with application to carbonate diagenesis. *Geochimica cosmochimica Acta,* 54: 3123-2137.

Bernecker, T., Partridge, A.D., and Webb, J.A., ms. Mid-late Tertiary temperate carbonate deposition, offshore Gippsland Basin, southeastern Australia. SEPM Vol., Cool & Cold-Water Carbonates (in review).

Berggren, W.A., Kent, D.V., Swisher, C.C., and Miller, K.G., 1995a: A revised Paleogene chronology and chronostratigraphy. *In* Berggren, W.A., and Kent, D.V., (eds), *Geochronology, Time Scales and Stratigraphic Correlation. Society of Economic Paleontologists and Mineralogists, Special Publication.*

Berggren, W.A., Kent, D.V., Swisher, C.C., and Miller, K.G., 1995b: A revised Neogene chronology and chronostratigraphy. *In* Berggren, W.A., and Kent, D.V., (eds), *Geochronology, Time Scales and Stratigraphic Correlation. Society of Economic Paleontologists and Mineralogists, Special Publication.*

Bone, Y., James, N.P., and Kyser, T.K., 1992. Syn-sedimentary detrital dolomite in Quaternary cool-water carbonate sediments, Lacepede Shelf, south Australia. *Geology,* 20: 109-112.

Buddemeier, R.W., and Oberdofer, J.A., 1986. Internal hydrology and geochemistry of coral reefs and atoll islands: key to diagenetic variations. *In* Schroeder, J.H., and Purser, B.H., (eds), *Reef Diagenesis,* Springer Verlag, Berlin: 91-111.

Burchette, T.P., and Wright, V.P., 1992. Carbonate ramp depositional systems. *Sedimentary Geology,* 79: 3-57.

Chaproniere, G.C.H., Shafik, S., Truswell, E.M., Macphail, M.K., and Partridge, A.D., 1995. Australian Phanerozoic Timescales, 10. Cainozoic. Australian Geological Survey Organisation, Record 1995/.

DiMichele, W.A., 1994. Ecological patterns in time and space. *Paleobiology,* 20: 89-92.

Fanning, K.A., Byrne, R.H., Breland, J.A., Elsinger, W.S., and Pyle T.E., 1981. Geothermal springs of the west Florida continental shelf: evidence for dolomitisation and radionuclide enrichment. *Earth and Planetary Science Letters,* 52: 345-354.

Feary, D.A., 1995. Proposal for an ODP site survey cruise by the R/V Rig Seismic in the western Great Australian Bight. Australian Geological Survey Organisation, Record 1995/67: 71 pp.

Feary, D.A., and James, N.P., 1995. Cenozoic biogenic mounds and buried Miocene(?) barrier reef on a predominantly cool-water carbonate continental margin, Eucla Basin, western Great Australian Bight. *Geology,* 23: 427-430.

Feary, D.A., James, N.P., and McGowran, B., 1994. Cenozoic Cool-water Carbonates of the Great Australian Bight: reading the record of Southern Ocean evolution, sealevel, paleoclimate, and biogenic production. Australian Geological Survey Organisation, Record 1994/62: 92 pp.

Frakes, L.A., and 21 Co-Authors, 1987. Australian Cretaceous shorelines, stage by stage. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 59: 31-48.

Frank, T.D., and Lohmann, K.C., 1995. Early cementation during marine-meteoric fluid mixing: Mississippian Lake Valley formation, New Mexico. *Journal of Sedimentary Research,* A65: 263-273.

Hanshaw, B.B., and Back, W., 1980. Chemical mass wasting of the northern Yucatan Peninsular by groundwater dissolution. *Geology,* 8: 222-224.

Haq, B.U., 1993. Deep-sea response to eustatic change and significance of gas hydrates for continental margin stratigraphy. *In* Posamentier, H.W., Summerhayes, C.P., Haq, B.U., and Allen, G.P., (eds), *Sequence stratigraphy and facies associations. International Association of Sedimentologists, Special Publication* 18: 93-106.

Harrison, R.S., 1975. Porosity in Pleistocene grainstones from Barbados: some preliminary observations. *Bulletin of Canadian Petroleum Geology,* 23: 383-392.

Hird, K., and Tucker, M.E., 1988. Contrasting diagenesis of two Carboniferous oolites from south Wales: a tale of climatic influence. *Sedimentology,* 35: 587-602.

Holdgate, G., and Gallagher, S., ms. Paleoenvironments and sequence stratigraphy of Tertiary cool-water carbonates, Gippsland Basin, SE Australia. SEPM Vol., Cool & Cold-Water Carbonates (in review).

Huber, B.T., and Watkins, D.K., 1992. Biogeography of Campanian-Maastrichtian calcareous plankton in the region of the Southern Ocean: paleogeographic and paleoclimatic implications. *In* Kennett, J.P., and Warnke D.A., (eds), *The Antarctic paleoenvironment: a perspective on global change, Part One*: Antarctic Research Series, v. 56, American Geophysical Union, Washington D.C.: 31-60.

James, J.M., 1992. Corrosion par melange des eaux dans les grottes de la plaine de Nullarbor, Australie. *Karst et Evolutions Climatiques*: 333-348.

James, J.M., Rogers, P., and Spate, A.P., 1989. Genesis of the caves of the Nullarbor Plain, Australia. *Proceedings, 10th International Congress on Speleology.*, Budapest: 263-265.

James, N.P., 1983. Reefs. *In* Scholle, P.A., Debout, D.G., and Moore, C.H., (eds), *Carbonate Depositional Environments, Memoir, American Association of Petroleum Geologists,* 33: 345-462.

James, N.P., Boreen, T.D., Bone, Y., and Feary, D.A., 1994. Holocene carbonate sedimentation on the west Eucla Shelf, Great Australia Bight: a shaved shelf. *Sedimentary Geology,* 90: 161-177.

James, N.P., Bone, Y., and Kyser, T.K., 1993. Shallow burial dolomitisation of Cenozoic cool-water calcitic deep shelf limestones, southern Australia. *Journal of Sedimentary Petrology,*. 63: 528-538.

James, N.P., and Bone, Y., 1988. Petrogenesis of Cenozoic temperate water calcarenites, south Australia: a model for meteoric/shallow burial diagenesis of shallow water calcite sediments. *Journal of Sedimentary Petrology,* 59: 191-203.

James, N.P., and Bone, Y., 1991. Origin of a cool water Oligo-Miocene deep shelf limestone, Eucla Platform, Southern Australia. *Sedimentology,* 38: 323-341.

James, N.P., and von der Borch C.C., 1991. Carbonate shelf edge off southern Australia: A prograding open platform margin. *Geology,* 19: 1005-1008.

Jenkins, D.G., 1974, Paleogene planktonic foraminifera of New Zealand and the Austral region. *Journal of Foraminiferal Research*, v. 4: 155-170.

Jenkins, D.G., 1985, Southern mid-latitude Paleocene to Holocene planktic foraminifera. *In* Bolli, H.M., Saunders, J.B., and Perch-Nielsen, K., *Plankton stratigraphy (vol. 1),* Cambridge, Cambridge University Press: 263-282.

Jenkins, D.G., 1993a. Cenozoic southern mid- and high-latitude biostratigraphy and chronostratigraphy based on planktonic foraminifera. *In* Kennett, J.P., and Warnke D.A., (eds), 1993, The Antarctic paleoenvironment: a perspective on global change, Part Two: Antarctic Research Series, v. 60, American Geophysical Union, Washington D.C.: 125-144.

Jenkins, D.G., 1993b. The evolution of the Cenozoic southern high- and mid-latitude planktonic foraminiferal faunas. *In* Kennett, J.P., and Warnke D.A., (eds), 1993, The Antarctic paleoenvironment: a perspective on global change, Part Two: Antarctic Research Series, v. 60, American Geophysical Union, Washington D.C.: 175-194.

Kohout, F.A., Henry, H.R., and Banks, J.E., 1977. Hydrogeology related to the geothermal conditions of the Floridan Plateau. *Florida Bureau of Geology, Special Publication* 21: 1-39.

Li, Q., and McGowran, B., ms. The Miocene foraminifera in the Lakes Entrance section in east Gippsland, southeastern Australia: systematics and communities. *Association of Australasian Palaeontologists, Memoir.*

Lohmann, K.C., 1988. Geochemical patterns of meteoric diagenetic systems and their application to studies of paleokarst. *In* James, N.P., and Choquette, P.W., (eds), *Paleokarst*, Springer-Verlag, New York: 58-80.

Lowry, D.C., 1970. Geology of the western Australian part of the Eucla Basin. *Geological Survey of Western Australia, Bull*etin 122: 201 pp.

McGowran, B, 1991. Maastrichtian and early Cainozoic, southern Australia: foraminiferal biostratigraphy. *In* Williams, M.A.J., De Deckker, P., and Kershaw, A.P., (eds), *The Cainozoic of the Australian region*: Geological Society of Australia, Special Publication 18: 79-98.

McGowran, B., and Li, Q., in press. Ecostratigraphy and sequence biostratigraphy, with a neritic foraminiferal example from the Miocene in southern Australia. Historical Biology.

McGowran, B., Li, Q., and Moss, G.D., ms. The neritic carbonate record in southern Australia: the biogeohistorical framework. SEPM Vol., Cool & Cold-Water Carbonates (in review).

McKenzie, J.A., Isern, A., Elderfield, H., Williams, A., and Swart, P.K., 1993. Strontium isotope dating of paleoceanographic, lithologic, and dolomitization events on the northeastern Australian margin, Leg 133. *In* McKenzie, J.A., Davies, P.J., Palmer-Julson, A., et al., *Proceedings of the Ocean Drilling Program, Scientific Results*, 133: College Station, TX (Ocean Drilling Program): 489-498.

Marshall, J.F., 1986. Regional distribution of submarine cements within an epicontinental reef system: Central Great Barrier Reef, Australia. *In* Schroeder, J.H., and Purser, B.H., (eds), *Reef Diagenesis*: 8-26.

Melim, L.A., Swart, P.K., and Maliva, R.G., 1995. Diagenesis of carbonates from the Bahamas Drilling Project, western margin Great Bahama Bank: Meteoric versus marine burial diagenesis. *Society of Economic Palaeontologists and Mineralogists, Special Publication*, (in press).

Meyers, W.J., 1978. Carbonate cements: their regional distribution and interpretation in Mississippian limestones of south-western New Mexico. *Sedimentology*, 25: 371-400.

Meyers, W.J., 1989. Trace element and isotope geochemistry of zoned calcite cements, Lake Valley Formation (Mississippian, New Mexico): insights from rock water interaction modelling. *Sedimentary Geology*, 65: 355-370.

Meyers, W.J., and Hill, B.E., 1983. Quantitative studies of compaction in Mississippian skeletal limestones, New Mexico. *Journal Sedimentary Petrology*, 53: 231-242.

Meyers, W.J., and Lohmann, K.C., 1985. Isotope geochemistry of regionally extensive calcite cement zones and marine components in Mississippian limestones, New Mexico. *Society of Economic Palaeontologists and Mineralogists, Special Publication* 26: 223-239.

Miller, K.G., 1994. The rise and fall of sea level studies: are we at a stillstand? *Paleoceanography*, 9: 183-184.

Moss, G.D., 1995. The Oligocene of southern Australia: ecostratigraphy and taxic overturn in neritic foraminifera. PhD thesis, The University of Adelaide.

Nelson, C.S., Harris, G.J., and Young, H.R., 1988. Burial dominated cementation in non-tropical carbonates of the Oligocene Te Kuiti Group, New Zealand. *Sedimentary Geology*, 60: 233-250.

Paull, C.K., Fullagar, P.D., Bralower, T.J., and Rohl, U., 1995. Sea water ventilation of mid-Pacific Guyots drilled during leg 143. *In* Sagar, W, Winterer, E., Firth, J., et al., *Proceedings of the Ocean Drilling Program, Scientific Results*, 143: College Station, TX (Ocean Drilling Program): 231-241.

Rao, C.P., 1990. Geochemical characteristics of cool temperate carbonates, Tasmania, Australia. *Carbonates & Evaporites*, 5: 209-221.

Rao, C.P., and Amini, Z.Z., 1995. Faunal relationship to grain-size, mineralogy and geochemistry in recent temperate shelf carbonates, western Tasmania, Australia. *Carbonates & Evaporites*, 10: 114-123.

Reeckmann, S., 1988. Diagenetic alterations in temperate shelf carbonates from south-eastern Australia. *Sedimentary Geology*, 60: 209-219.

Rockford, D.J., 1986. Seasonal changes in the distribution of Leeuwin Current waters off southern Australia. *Australian Journal of Marine and Freshwater Research*, 37: 1-10.

Saller, A.H., 1984. Petrologic and geochemical constraints on the origin of subsurface dolomite, Enewetak Atoll: an example of dolomitisation by normal sea-water. *Geology*, 12: 217-220.

Sandberg, P.A., 1983. An oscillating trend in Phanerozoic non-skeletal carbonate mineralogy. *Nature*, 305: 19-22.

Sanders, J.I., and Steel, G., 1982. Improved structural resolution from 3D surveys in Australia. APEA Journal, 22: 17-41.

Simms, M., 1984. Dolomitisation by groundwater flow systems in carbonate platforms. *Transactions of the Gulf Coast Association of Geological Societies*, 34: 411-420.

Stott, L.D., and Kennett, J.P., 1990. Antarctic Paleogene planktonic foraminiferal biostratigraphy: ODP Leg 113, sites 689 and 690. *In* Barker, P.F., Kennett, J.P., O'Connell, S., et al., *Proceedings of the Ocean Drilling Program, Scientific Results*, 113: College Station, TX (Ocean Drilling Program): 549-569.

Swart, P.K., 1993. The formation of dolomite in sediments from the continental margin of northeastern Queensland. *In* McKenzie, J.A., Davies, P.J., Palmer-Julson, A., et al., *Proceedings of the Ocean Drilling Program, Scientific Results*, 133: College Station, TX (Ocean Drilling Program): 513-523.

Swart, P.K., and Guzikowski, M., 1988. Interstitial-water chemistry and diagenesis of periplatform sediments from the Bahamas, ODP Leg 101. *In* Austin, J.A., Jr, Schlager, W., Palmer, A.A., et al., *Proceedings of the Ocean Drilling Program, Scientific Results*, 101: College Station, TX (Ocean Drilling Program): 363-380.

Tucker, M.E., and Wright, V.P., 1991. *Carbonate Sedimentology*. Blackwell, Oxford, 482 pp.

Vahrenkamp, V.C., 1991. Episodic dolomitisation of late Cenozoic carbonates in the Bahamas. *Journal of Sedimentary Petrology*, 61: 1002-1014.

Wei W., 1992, Paleogene chronology of Southern Ocean drill holes: an update. *In* Kennett, J.P., and Warnke D.A., (eds), 1992, The Antarctic paleoenvironment: a perspective on global change, Part One: Antarctic Research Series, v. 56, American Geophysical Union, Washington D.C.: 75-96.

Whitaker, F.F., and Smart, P.L., 1990. Circulation of saline groundwaters in carbonate platforms: Evidence from the Great Bahama Bank. *Geology*, 18: 200-204.

Whitaker, F.F., and Smart, P.L., 1993. Circulation of saline groundwaters in carbonate build-ups: an overview and case study from the Bahamas. *American Association of Petroleum Geologists, Studies in Geology* 32: 113-132.

Whitaker, F.F., Smart, P.L., Vahrenkamp, V.C., Nicholson, H., and Wogelius, R., 1994. Dolomitisation by near-normal sea water? Field evidence from the Bahamas. *International Association of Sedimentologists, Special Publication* 21: 111-132.

Whitaker, F.F., Sanford, W.E., and Smart, P.L., 1995. Thermally driven groundwater circulation in isolated carbonate platforms and its implications for dolomitisation. *Geological Society of American Annual Meeting (Abstracts)*.

Wilkinson, B.M., 1979. Biomineralogy, paleoceanography and the evolution of calcareous marine organisms. *Geology*, 7: 524-527.

Wilkinson, B.M., Owen, R.M., and Carroll, A.R., 1985. Submarine hydrothermal weathering, global eustacy and carbonate polymorphism in Phanerozoic marine oolites. *Journal of Sedimentary Petrology*, 55: 171-183.

Wilson, E.N., Hardy, L.A., and Phillips, O.M., 1990. Dolomitization front geometry, fluid flow patterns, and the origin of massive dolomite: the Triassic Latemar buildup, northern Italy. *American Journal of Science,* 290: 741-796.

APPENDIX 1 - DATA SUBMITTED TO THE ODP DATABANK IN OCTOBER 1995

In each case, data for Site GAB-13A were not included in this data submission, as this site was defined following the recent advice that the *Joides Resolution* may not be able to drill the three sites located in shallow water depths (50-52 m). The data submitted were:

• uninterpreted and interpreted seismic sections across each proposed site (map showing these seismic lines is on page 7):
- Line JA90-12 (cdp's 19004-30500), showing sites GAB-03A, GAB-04A, and exploration drillhole Jerboa-1;
- Line JA90-23 (shallow) (cdp's 4-14800), showing sites GAB-05B, GAB-06B, GAB-10B, GAB-11A, and exploration drillhole Jerboa-1;
- Line JA90-23 (deep) (cdp's 15300-19078), showing site GAB-01A;
- Line JA90-27 (cdp 4-10000), showing site GAB-04A;
- Line JA90-31 (cdp 4-10000), showing sites GAB-07A, GAB-08A, and GAB-09A;
- Line JA90-33 (cdp 4-7838), showing site GAB-12B;
- Line JA90-35 (cdp 9000-19824), showing site GAB-02B.

• Maps showing:
- Seismic lines and proposed ODP sites
- Contoured bathymetry

• A package of data for each site, including ODP Site Summary Forms, velocity profiles and time-depth plots, and page-sized interpreted and uninterpreted seismic data. Note that site designations now conform to the JOIDES recommendations, and that all 'B' sites are sites that have been moved following comments from earlier (Spring 1995) panel reviews. The velocity profiles presented are based on NMO (stacking) velocities; although these are an imperfect basis for estimating depths, they are the only data available at present.