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

REVISED ODP PROPOSAL - DECEMBER 1994

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

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

REVISED ODP PROPOSAL - DECEMBER 1994

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PREFACE TO REVISED PROPOSAL

This revised proposal is a major upgrading of Proposal 367-Rev (James and Feary, 1993) which was assessed and ranked in Spring 1994. This revision takes into account the scientific and technical comments provided to the proponents following assessment of the previous proposal, and makes significant changes:

- in response to OHP comments, we have greatly increased the paleoceanographic component of the proposal, including the incorporation of material from LOI 16 submitted by McGowran in 1993; we have reduced the number of shallow water sites and refined the location of deep water sites; and we have taken into account the draft OHP White Paper (July 1994) objectives.
- in response to SGPP comments, we have reduced the total number of sites to fit into a single drilling leg; we have improved the fluid flow and diagenetic objectives and rationale; and we have provided a more coherent correlation of the onshore and offshore sections.
- in response to comments by TECP, to the effect that the proposed site in the Southwest Ceduna Tectonic Accommodation Zone is not an important TECP thematic objective, we have deleted that site (although many of its original objectives will be addressed at relocated Site GAB-2).
- in response to technical comments from the panels and from ODP Operations, we have removed the requirement for DCS capability; and refined the drilling strategy and timetable.

Please note that we do not repeat here many of the more extensive discussions presented in our original submissions (367-Rev and LOI 16) unless we have substantially modified those discussions as outlined above; this revision should therefore be considered in conjunction with the original submissions.

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, hydrology, 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 show a detailed accretionary history of progradation, erosion, and biogenic mound growth. The subsidence history is relatively simple, resulting in a 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 12 holes 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 a 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. SCIENTIFIC RATIONALE AND OBJECTIVES

OBSERVATIONS:

1. Australia's southern margin faced the evolving Southern Ocean throughout the Cenozoic, and accumulated a carbonate-rich stratigraphic record un-matched anywhere in the sensitive mid-latitudes.

2. Although one of the major controlling influences on global circulation and climate, the paleoceanographic development of the Southern Ocean is not nearly as well known as that of the high latitude North Atlantic (Kennett and Barron, 1992).

3. Major paleoceanographic problems that potentially can be answered from the proposed drilling transect are; i) the relationship between circulation patterns in the deep ocean and on the shelf during times of warm versus cold oceanic conditions; ii) the precise timing and nature of the opening of the Tasman Gateway; iii) the evolution and effect of the Leeuwin Current; and iv) the relationship between primary productivity and cool-water carbonate development.

4. In comparison to rimmed carbonate platforms formed in warm-water ('tropical') environments, the characteristics and processes controlling the formation of cooler-water ('temperate' or 'subtropical') carbonate platforms are poorly understood. The Eucla Basin carbonate platforms of southern Australia are two of the largest (together totalling ≈380,000 km^2) and longest-lived (late Middle Eocene to early Middle Miocene; ≈28 million years; Late Miocene to present; ≈13-14 million years) cool-water carbonate platforms known on earth; they are also some of the least known and understood platforms.

5. Cool-water carbonates, with their predominantly calcite mineralogy, are generally uncemented and consequently there should be a minimum of diagenetic alteration.

6. The accuracy and applicability of models describing deposition on carbonate margins are critically dependant on the derivation of more precise parameters for cool-water environments.

8. Drilling at 12 sites on a transect across the Eucla Basin provides enormous potential to address fundamental scientific questions central to the ODP mandate.

Carbonate sediments and sedimentary rocks contain a particularly sensitive record of paleoceanographic and biostratigraphic evolution. The focus of ODP carbonate continental margin drilling to date has largely been in warm-water environments. There is a complete sedimentary realm whose nature and history has not yet been investigated; that of cool-water platform carbonates. These sediments, formed where seawater temperatures rarely rise above 20°C, are biogenic sediments which commonly mantle continental margins in mid- and high-latitudes. They are an untapped storehouse of information regarding the evolution of global climates, eustacy, and marine biology.

This proposal seeks to drill a series of holes across the southern Australian continental margin in the Great Australian Bight (Fig. 1). A transect of 12 sites is proposed, to sample the Cenozoic cool-water carbonate succession in shelf, continental slope, upper slope terrace, and continental rise environments.

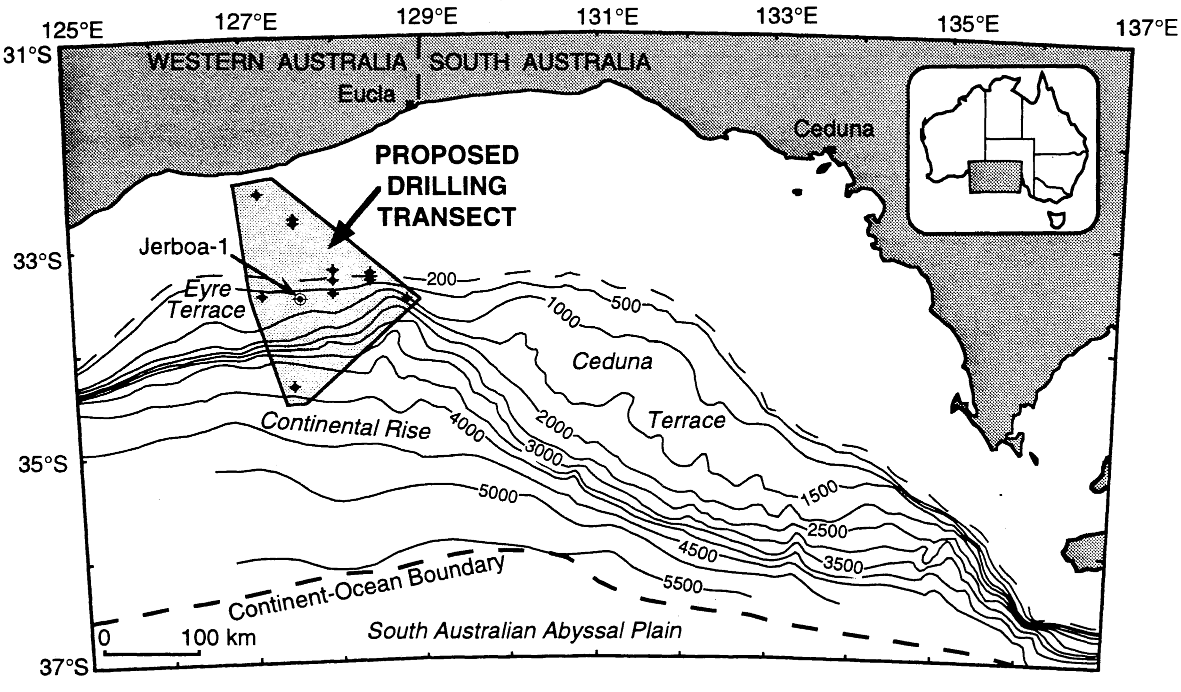


Figure 1. Map showing bathymetric features and the proposed ODP drilling transect in the western Great Australian Bight. The location of exploration drillhole Jerboa-1 ia also shown.

The southern Australian continental margin is the ideal location to study cool-water carbonate facies and evolution. The shelf has been the site of cool-water carbonate sedimentation since Eocene time, resulting in an almost 1 km thick succession (Fig. 2). It is now the largest area on the globe composed of such sediments. In addition, slight tectonic tilting in the late Miocene has led to subaerial exposure of Eocene-Middle Miocene strata in extensive, shallow basins. These sediments form a more compressed and less continuous section than exists offshore, yet they have permitted the development of actualistic models for the formation and development of these carbonates which can be tested and greatly expanded by drilling.

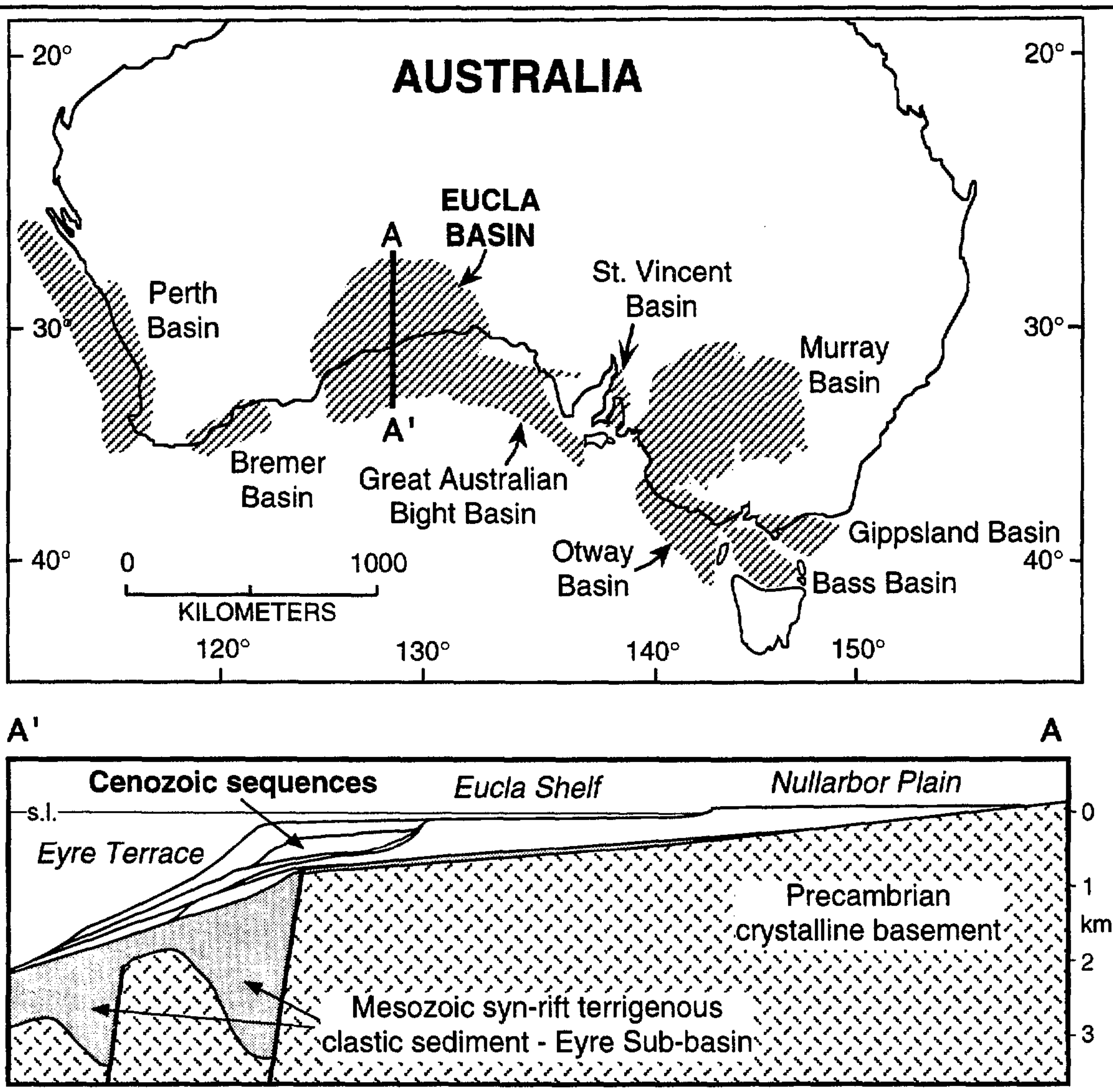


Figure 2. Map (top) showing location of the Eucla Basin, together with other Cenozoic basins of southern Australia. The schematic cross-section (A-A′) across the Eucla Basin (bottom) shows the distribution and thickness trends of Mesozoic (shaded) and Cenozoic (unshaded) sequences. Note that the Mesozoic succession is primarily concentrated in the Eyre Sub-basin. Based on Feary and James (in press) and Lowry (1970).

A critically important benefit of drilling in the Great Australian Bight is that, as the shelf is latitudinally parallel to the southern margin of the Australian plate, the sediments contain a record of the development of the Southern Ocean. In particular, the region offers the potential to collect high resolution stable isotope and biostratigraphic profiles to clarify several important stages in the evolution of the Southern Ocean: the initial early Eocene climatic deterioration; the possible late Eocene warming; the terminal Eocene cooling event and "Rupelian lag" prior to the early Oligocene sealevel fall; the Miocene oscillation and climatic optimum; and the Plio-Pleistocene sealevel oscillations.

Great Australian Bight drilling will allow six fundamental scientific topics central to the ODP mandate to be addressed:

1) The paleoceanographic history of a carbonate-dominated, mid-latitude continental margin and adjacent basin during evolution of the Southern Ocean.

2) The formulation of models for carbonate sedimentation on continental margins bathed predominantly by cool oceanic waters.

3) Determination of the Southern Ocean basin sealevel record and the effect of sealevel fluctuations on stratigraphic packaging and early diagenesis of cool-water carbonates.

4) The circulation patterns of shallow subsurface fluids in an area of low hydraulic gradient and minimal recharge.

5) Early seafloor and shallow burial diagenesis and dolomitization of calcite-dominated sediments.

6) The pace and style of evolution of mid-latitude oceanic and neritic biotas.

Drilling in the Great Australian Bight will also provide essential and original information on the contrast between the sedimentological, paleontological, paleoceanographic, and climatic records from warm- and cool-water realms, and will allow the development of well-constrained and much needed models that can be used in the interpretation of older Mesozoic and Paleozoic open shelf carbonate systems.

Finally, on a philosophical level, studies on land and from modern cool-water carbonates have yielded first-order models, allowing us to predict what the response of the system should be to various allogenic forces. Furthermore, earlier ODP/DSDP drilling in the Southern Ocean has established a temporal framework within which to predict the nature and pace of such changes. In line with the clear need of ODP to shift into an experimental phase, this proposal is problem-driven in that our pre-drill predictions are based on a series of hypotheses, derived from our current data base, which can be tested by drilling.

THEME 1: "Australia's vast southern margin provides a unique window to the Southern Ocean; the engine driving global climates".

1.1 PALEOCEANOGRAPHIC OBJECTIVES

The southern Australian margin faces the engine room of the global exogenic system--the widening and evolving Southern Ocean. To the north of Australia, the South Equatorial Current flows as an integral, low-salinity, surface component of the global thermohaline system (Fig. 3). Due to squeezing in the north and counter-gyral deflection in the south, a component of the South Equatorial Current is hived off episodically as the Leeuwin Current. During warming times, the Leeuwin Current switched on and its influence was felt in pelagic, neritic and terrestrial environments, and biotas along much of the southern margin. During times of cooling, the Subtropical Convergence shifted northwards and the Leeuwin Current shut down. These generalizations have been shown to hold at fourth- to fifth-order scales (the influx of warm biotas from the west during the last interglacial and the Holocene) and at third-order scales (the warm neritic biotas of the late Eocene, middle Miocene and middle Pliocene). The contrast between warm and cool signals is enhanced by the on/off behaviour of the Current.

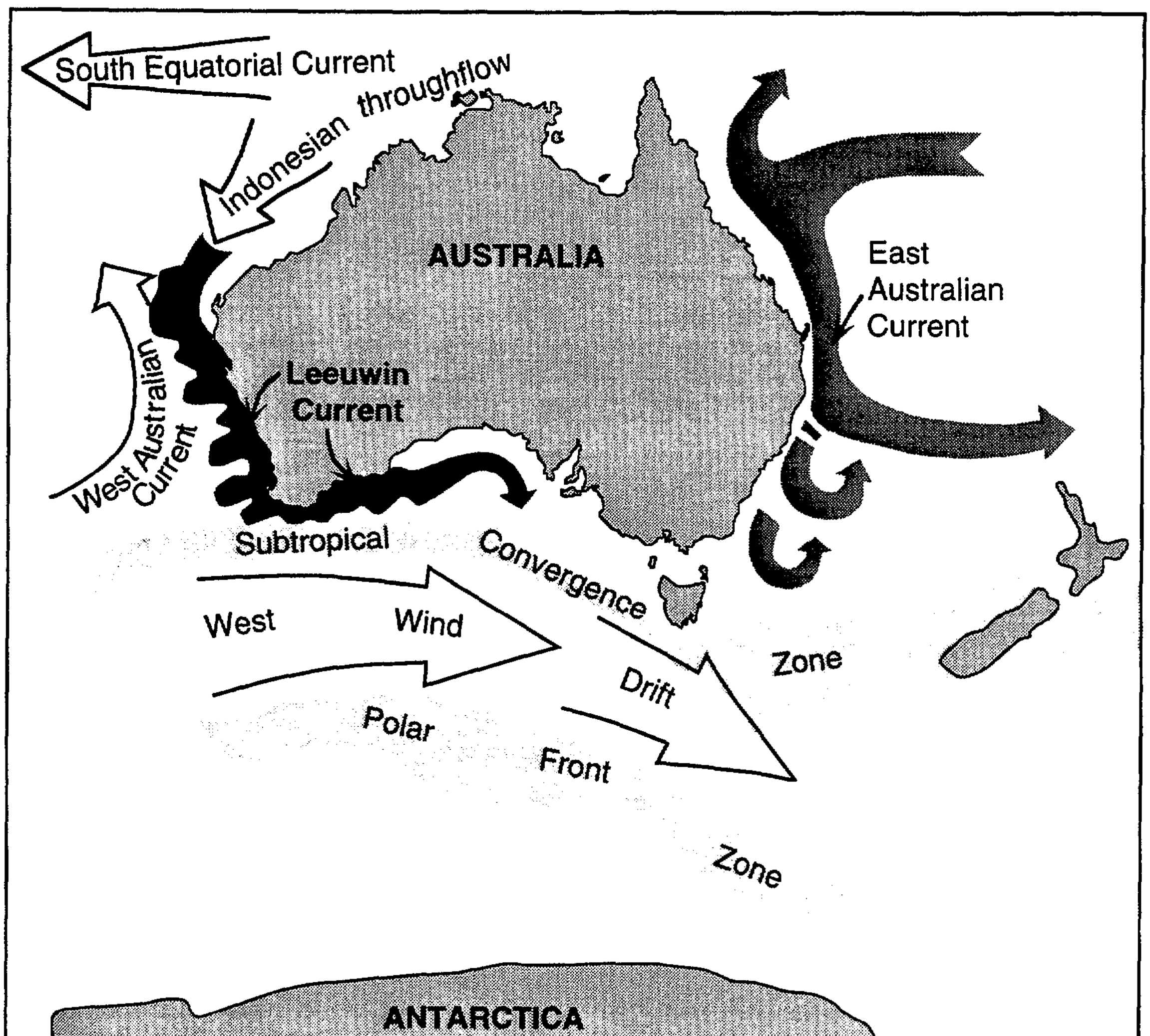


Figure 3. The Leeuwin Current hives off from the South Equatorial Current, which is part of the low-salinity, surface, "returning" component of the global thermohaline system. Consequently, drilling off the western part of the southern margin not only samples the Leeuwin Current effect on southern extratropical oceanic environments, but samples by proxy the global system itself.

The extratropical southern Australian margin is unique:

- in presenting such a longitudinally long face to the Southern Ocean;
- in sampling, using the Leeuwin Current as a proxy, the global thermohaline circulation system;
- in occupying the box seat during development of the CircumAntarctic Current in the late Paleogene and Neogene;
- in having a carbonate-rich, warm/cool, transgressive/regressive, stratigraphic and paleobiological succession whose contrasts are enhanced by the episodic effect of the Leeuwin Current.
- due to lack of major drainage to the south for much of the Cenozoic, the succession is less diluted by siliciclastics and richer in biological and chemical signals than is the case on any other southern extratropical margin.

The southern Australian neritic record during the Cenozoic consists of marine transgressions which fall chronostratigraphically into four packets or mega-sequences (Fig. 4). Instead of treating hiatus merely as lost record, we can treat hiatus as data--as a neritic record of the evolution of the Southern Ocean. In addition, deeper parts of the margin are likely to contain more continuous pelagic records, potentially providing a semi-continuous record of Southern Ocean development. The four chronostratigraphic packets in the neritic record (Fig. 4) can be identified as second-order sequences; much of the succession can be identified as third-order sequences; and the shallower carbonate-rich facies are characterized by hard grounds and other fourth- to fifth-order punctuations.

Great Australian Bight drilling will directly address a number of high priority objectives of OHP, as recently stated in the draft (July, 1994) OHP White Paper. OHP Experiment 1 requires "Drilling to assess southern hemisphere climates, patterns of global deep water circulation, and biosphere changes in the South Atlantic and in the South Pacific", an objective that is central to this proposal. We also seek to drill sequences which potentially contain important records of abrupt Cenozoic ocean-climate changes on both long- and short-tem scales (OHP Experiments 2 and 3), and have as a central objective the characterisation of the early Cenozoic, radically different state of the critically important Southern Ocean.

1.1.1 The Great Australian Bight and global paleoceanographic evolution:

A - The early Paleogene. The Paleocene to early Eocene record has been greatly clarified by successful drilling at high southern latitudes (references in Zachos et al., 1994). The Great Australian Bight region preserves a succession of Australia-wide siliciclastic transgressions (the 'Ceduna' to 'Burrungule' transgressions; Fig. 4). Certainly drilling into the early Paleogene (Sites GAB-5 and GAB-6) will impact powerfully on the marine and terrestrial biogeohistory of southern Australia, but we predict less impact in the reverse direction, on global and oceanic history at large.

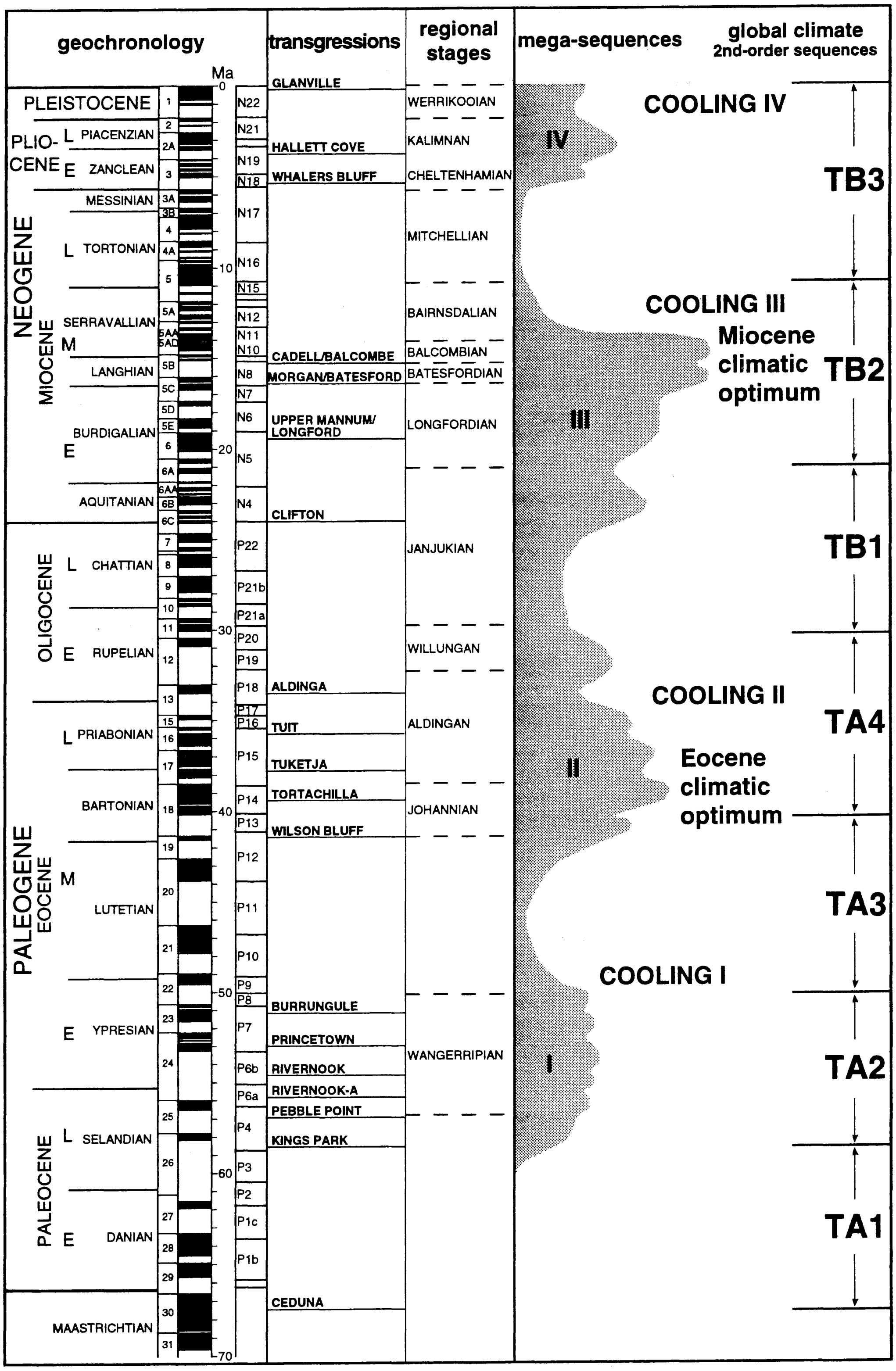


Figure 4. A compilation of southern Australian marginal stratigraphy, emphasizing the four mega-sequences; transgressions; regional stages; and the correlation--sometimes tentative--to the integrated geochronology.

B - The early middle Eocene following initial cooling. This interval, containing indications of the first Cenozoic cooling event (Cooling I - Figs 4, 5), is one of the least well-understood parts of Cenozoic time. The recovered oceanic record is poor, as shown by the ten-million-year gap within the time-slice succession of Zachos et al. (1994). The neritic record of southern Australia is totally unknown for the ten-million-year gap from the 'Burrungule' to 'Wilson Bluff' transgressions (Fig. 4). The deeper water Sites GAB-1 and GAB-2 provide great potential for recovering a pelagic record during this poorly known interval.

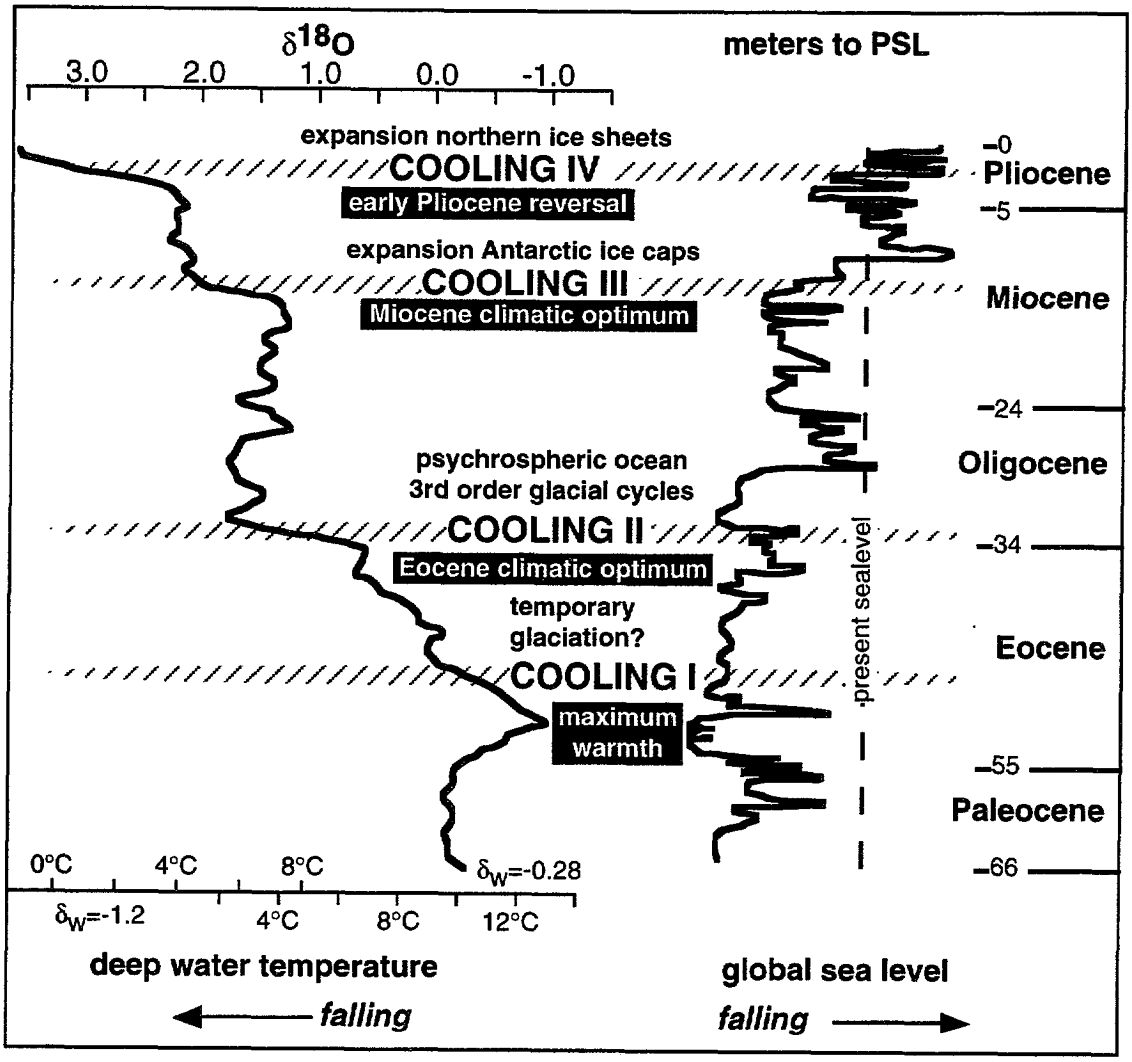


Figure 5. Comparison, emphasizing parallels, of a deepwater $\delta^{18}O$ curve (from Miller et al., 1987) and the "Exxon" sea level curve. The four cooling events and the highly generalized statements about global state are approximately correct at this second-order scale.

C - The late middle Eocene to middle Oligocene; the preconditioning and development of the psychrospheric ocean. The standard scenario for this critical interval of global oceanic evolution is of falling bottom temperatures, broadly constant or gradually cooling surface temperatures, with a sudden plunge by both in the earliest Oligocene (e.g., Zachos et al., 1994). Once again, the poor oceanic-stratigraphic record is emphasized by the gap in the Zachos et al. (1994) timeslices: they could develop an adequate data base only up to the Chron C15 to C12R interval. Detailed, modern, geomagnetically- and biostratigraphically-constrained sections for isotopic and paleobiological time series analysis simply are not widely available. Recovery of high resolution pelagic and neritic sections for this critical interval will provide the basis for refining and constraining models of oceanic evolution, and particularly will enable determination of the accuracy of recent models which suggest that there was a significant warming episode (the "Khirthar Restoration" of McGowran, 1989) in the late Eocene (McGowran, 1989; Frakes et al., 1994). The summary by Frakes et al. (1994) (using figures unadjusted for an ice effect or for latitudinal gradients in surface $\delta^{18}O$: see Zachos et al., 1994) indicates a marked warming in the later Eocene. This is in accord with widespread neritic and terrestrial evidence from the IndoPacific region, including southern Australia (McGowran, 1989), for such a warming event. This "Eocene Climatic Optimum" (Fig. 5) marks:

- a major change in global plate configuration;
- the most extensive transgressions in the Paleogene of southern Australia;
- the onset of carbonate sedimentation in southern Australia (seemingly isochronously across the Eucla and Great Australian Bight Basins);
- the probable initiation of the Leeuwin Current;
- a polewards movement of the 20°C SST isotherm by 40° latitude (Frakes et al., 1994).

This apparent warming event occurs in the chronological interval:

- about which there has been considerable paleoenvironmental and paleobiological controversy--the Terminal Eocene Event (TEE)*sensu lato* (Prothero, 1994, with references);
- critical to the transition from the chemically poorly-partitioned Paleogene ocean to the better-partitioned Neogene ocean (Seibold and Berger, 1993);
- during which there was the first significant transport of moisture to an already cold Antarctic region; perhaps coinciding with the development of the "modern" global thermohaline system (from which the Leeuwin Current hives off);
- preceding the sudden chilling at the end of the Eocene (*Cooling II*); the most spectacular (but poorly understood) cooling event of the entire Cenozoic.

That the later Eocene is paleoceanographically critical, but poorly sampled, is emphasized by a startling contrast in the Southern Ocean. Whereas there is an opaline silica window from Western Australia to New Zealand to Peru at middle to lower latitudes; at higher latitudes there is the first evidence, if imperfectly documented, of glacial/glaciomarine environments (Zachos et al., 1994). In southern Australia, the relatively incomplete chemical partitioning of the late

Paleogene compared to the Neogene is marked by the neritic succession of chert-carbonates, opal-A and opal-CT facies, and more chert-carbonates in the early Oligocene.

The carbonate-rich offshore sections of the Great Australian Bight are splendidly situated in time, and especially in space, to test and clarify this critical interval of oceanic transformation from the later Eocene warming event (the "Eocene Climatic Optimum" or "Khirthar Restoration") to the Terminal Eocene Event and the development of the psychrospheric ocean.

D - The Miocene oscillation and the Miocene climatic optimum. A central theme of this proposal is the known and inferred record of cool-water carbonate accumulation. Subsumed under "cool-water" are strong fluctuations in neritic and planktonic biotas, as a consequence of both paleoclimatic variation (with warm elements injected episodically by the Leeuwin Current alternating with cooler elements imposed by the Subtropical Convergence), and trophic resource variation (shown by concurrent planktonic and benthic evidence for alternating upwelling and oligotrophy) (Li and McGowran, 1994). These fluctuations occur at the third-order on a rising second-order trajectory, from the late Oligocene to the early middle Miocene climatic peak, and then falling to the late Miocene -- the Miocene oscillation (McGowran and Li, 1994).

We are well along the path of matching the fluctuations to the Oligocene and Neogene $\delta^{18}O$-based third-order glaciations as well as to the third-order sequences. However, transects in late Paleogene and Neogene carbonates will give this three-way third-order correlation--between sea level, climate, and regional biofacies tracts--a chronological rigour and thence a global significance that is somewhat lacking at present. If the biogenic reefs and mounds identified on seismic data (see below) can be correlated with deeper-water carbonates free of siliciclastics, then we predict that the alternation between the Leeuwin Current and the Subtropical Convergence will be detectable at fourth-order as well as the third-order scales.

E - The early Pliocene warm period. There is a broad chronological match between our evidence for a powerfully switched-on Leeuwin Current and a distinct interval with common rainforest taxa in the vertebrate assemblages of southern Australia (Tedford, 1994). Parochial as it sounds, the tightening of the marine component of this relationship will give us insights into the environmental forcing of biogeographic change and speciation--well within the charter of ODP. That possibility applies to the entire carbonate-rich succession from the later Eocene warming event onwards, in a particularly sensitive part of the generally sensitive mid-southern-latitudes.

1.1.2 The Great Australian Bight and productivity and upwelling in the cool-water carbonate domain:

The southern Australian continental margin is the best cool-water carbonate factory on the planet - a combination of a long continental margin facing the fertile Southern Ocean with its fluctuating subtropical convergence and broad marginal seas generally not swamped by detrital sediment from the land. The factory began production in the late middle Eocene, although hardly as productively as during the upswing of the Oligo-Miocene oscillation. The next steps arising from these observations are (i) to estimate rates of production in space (inner neritic to off-shelf) and in time (through the Neogene oscillations), and (ii) to clarify the trophic requirements of the contributing organisms.

The southern continental margin faces the Subtropical Convergence and the West Wind Drift. For most of the past 500,000 years, the Subtropical Convergence has been north of its present position (Howard and Prell, 1992), so that cooler and more strongly upwelling waters would have been more in evidence in the Bight than they are today; and indeed we have evidence (benthic foraminifera in a core from the slope) of intensified productivity implying intensified upwelling (Almond et al., 1993). The question here is: what can we say about these matters at longer Neogene and Palaeogene time scales, back in fact to the time when the Southern Ocean was very narrow? At present the answer is: very little at all, from the ocean, but a coherent if incomplete succession from the onshore and nearshore neritic record provides indications that should stimulate the search for an oceanic record of upwelling and productivity.

THEME 2: **"We present an ideal location to test the sedimentary facies response to climatic (temperate-subtropical-tropical) fluctuations within two of the world's largest and longest lived (Eocene to Middle Miocene; Late Miocene to present) carbonate platforms".**

1.2 COOL-WATER CARBONATE FACIES OBJECTIVES

The deposition and accumulation of platform (neritic) carbonate sediments under cool-water (ca. <20°C) conditions is poorly understood compared to warm-water carbonates, primarily because the data base is so small (Nelson, 1988; James and Kendall, 1992). Yet, because of their dominantly skeletal composition, nutrient-dependant biology, and low diagenetic potential, cool-water carbonates record the history of oceanic change in ways that are profoundly different from tropical carbonates.

Information concerning the way in which cool-water carbonate sediments are produced and the environmental conditions which determine their style of accumulation (Fig. 6) comes from studies of modern shelves largely in the eastern North Atlantic and Australia-New Zealand regions (Collins, 1988; Nelson, 1988; James et al; 1992; Boreen et al., 1993). The primitive models that have been developed are based on offshore information from one time period, together with data from Cenozoic onland exposures. Nowhere are there the critical exposures of middle and outer shelf, shelf-edge and slope facies exposed; they are still buried beneath extant shelves.

Sediment composition: Onshore exposures of Cenozoic carbonates in southern Australia confirm that the succession was largely deposited in cool-water. One of the fundamental questions that must be answered is - what is the composition of these carbonate platforms? Similarity of seismic style throughout the 3000 km-long southern Australian continental shelf indicates that the proposed drilling transect will reveal the makeup of the largest composite cool-water carbonate platform on the globe today. In Australian-New Zealand inner shelf environments, the main sediment producers are bryozoans (Nelson et al., 1988; Bone and James, 1993). However, in other cool-water areas, benthic foraminifers, serpulids, and echinoderms are more important. Is this just an artefact of inner shelf facies preservation? If bryozoan-dominated, the drilling transect will also provide an unparalleled opportunity to trace changes in taxonomic composition of this biota through time and within different facies.

Onshore middle Miocene warm-water facies are heterogeneous and, although locally rich in reef-building corals and green calcareous algae, are mainly inner shelf in character. It is critical to know whether these rocks have unique characteristics because they accumulated adjacent to cool-water settings, or are they merely typical of true warm-water, reef-dominated platforms. Are there any abiotic sediments such as ooid shoals in the sequence at such high latitudes?

Seismic images indicate that numerous mounds have developed on the shelf, shelf-edge, and upper slope throughout the Cenozoic (see below). What is the paleobiological, chemical, and mineralogical composition of these structures; did they grow preferentially during specific time periods; can their development be linked to paleoceanographic conditions (i.e. to specific cold- and warm-water periods); and are they vertically zoned?

All seismic profiles across the southern margin of Australia indicate that a large proportion of the youngest part of succession is made up of prograding clinoforms (James and von der Borch, 1991; Feary and James, in press). Such clinoforms seem to be a signature of cool-water platforms and ramps, and are postulated to be a product of accumulation dynamics (Boreen and James, 1992). There is little information regarding the composition of these deposits; specifically, are they produced by in-place, enhanced bioproduction along the shelf edge, or are they made up of finer-grained material produced on the shelf and swept offshore to accumulate below wavebase?

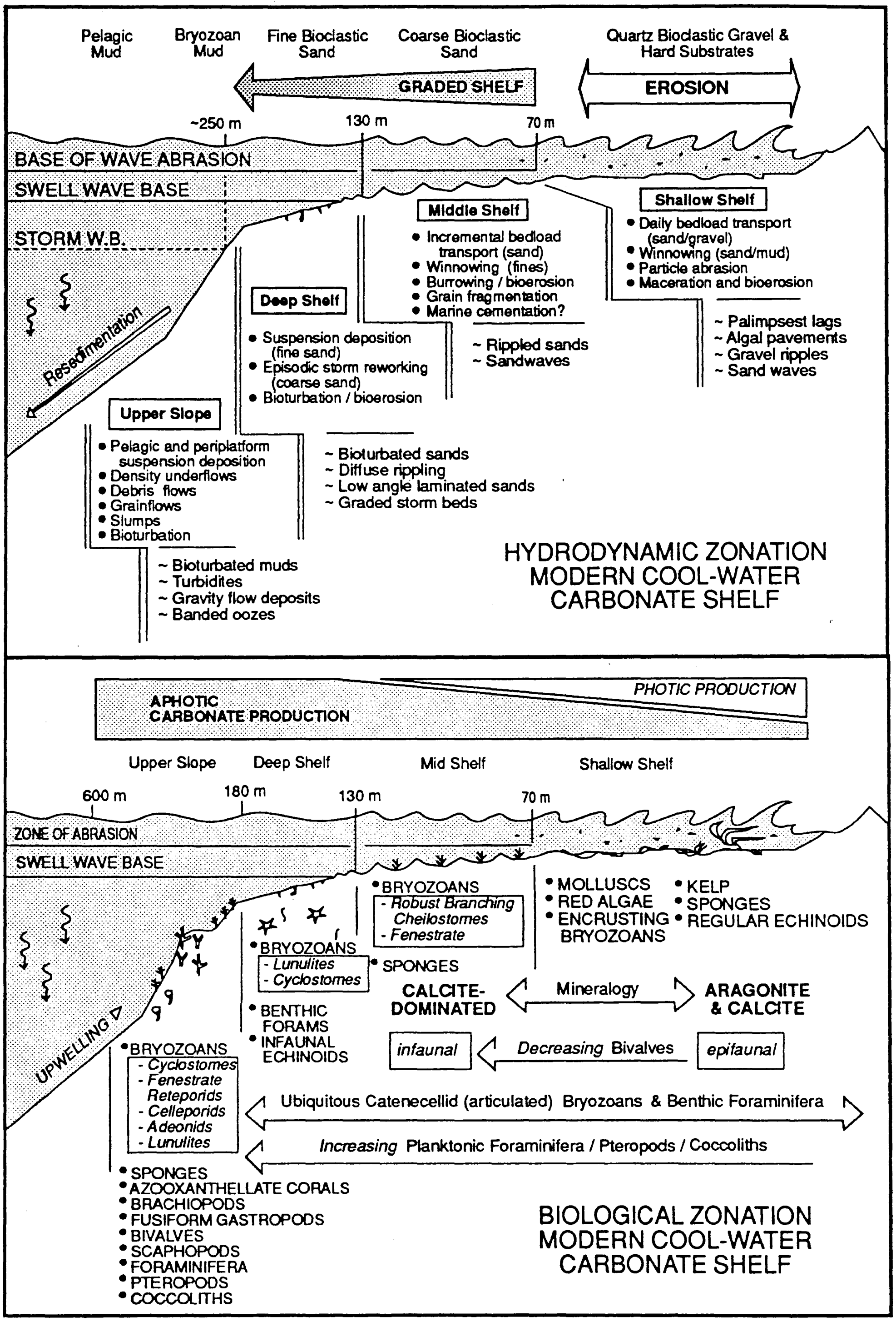


Figure 6. Generalized hydrodynamic and biological zonation of modern cool-water shelves off southern Australia (after Boreen et al., 1993). The hydrodynamic zonation (top) is determined by the intensity of open ocean swells which sweep the shelf because of the lack of an elevated rim. The most important interfaces are the base of wave abrasion and swell base. Biological zonation is dominated by bryozoans throughout, with coralline algae and molluscs being important in shallow water.

Accumulation dynamics: Cool-water carbonate shelves are, in hydrodynamic terms, hybrids, possessing some of the characteristics of both terrigenous clastic shelves and warm-water carbonate shelves. Sediments are produced on the shelf, in contrast to terrigenous clastic shelves where sediment is transported onto the shelf from the hinterland. Without the elevated rim that typifies warm-water carbonate shelves, however, the sediments are subject to the full sweep of oceanic waves and swells, as they are on terrigenous clastic shelves. Cenozoic exposures of inner shelf facies in Australia suggest that storm- and wave-dominated processes tend to control deposition. By contrast, many contemporaneous deposits in New Zealand are clearly tide-dominated. Are the models of wave-dominated shelf deposition developed onshore applicable throughout the Cenozoic?

The rate at which carbonate sediments accumulate is fundamental to understanding how continental shelves and banks develop. Short-term, cool-water carbonate accumulation rates have recently been documented for the first time (Boreen and James, 1992), but there is little information about long term accumulation rates. By collecting information from 1) different coeval facies across the depositional spectrum, 2) the same facies during depositional time periods subject to varying environmental parameters, and 3) both cool- and warm-water carbonates in the same section, the Eucla Platform should provide an unparalleled data set for use in modelling carbonate margin depositional systems.

THEME 3: "The Great Australian Bight drilling transect is the ideal location to determine the effect of sealevel fluctuations on stratigraphic packaging and early diagenesis of cool-water carbonates".

1.3 SEALEVEL OBJECTIVES

The Eucla Platform is rich in biogenic carbonate sediments that respond in a sensitive way to variations in sealevel, and contain vital geochemical information needed for linking sealevel changes to paleoceanography. This information can then be utilized to address two major questions of global and temporal significance; 1) what is the detailed sealevel history of the Southern Ocean basin, and can it be linked to paleoceanographic variations; and 2) how do cool-water carbonate platforms respond to changes in sealevel? Data addressing these questions from a Great Australian Bight drilling transect will directly contribute to high priority objectives of both SGPP (from a process perspective) and OHP (from an Ocean History perspective) (draft OHP White Paper, July 1994).

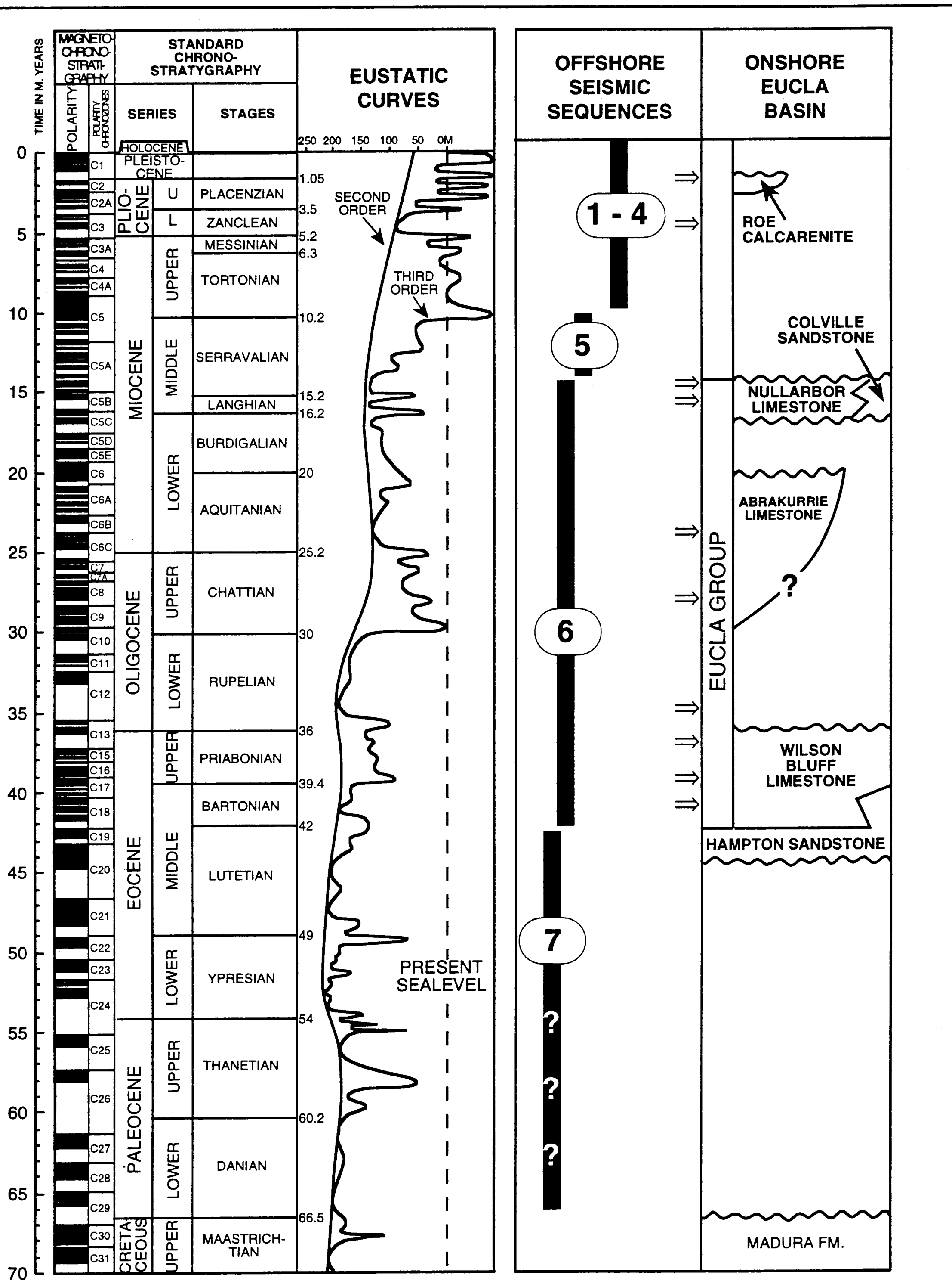


Figure 7. Chronostratigraphic comparison of onshore Eucla Basin sequences (Lowry, 1970; James and Bone, 1991) with tentatively dated offshore seismic sequences (after Feary and James, in press); plotted against the global sealevel curve (Haq et al., 1987). ⇒ represents an influx of larger foraminifers (and corals in the Miocene) in one or more of the southern Australian basins, indicating warm-water.

Global sealevel model: The sealevel history of the Australian side of the Southern Ocean has come largely from onshore successions in which the marine record is preserved only in highstand systems tracts (McGowran, 1986, 1989; James and Bone, 1991). Much of the deep sea record is either eroded (see below), or preserved adjacent to Antarctica in siliceous or glacial terrigenous clastic sediments. Seismic records, however, clearly show a thick and complex carbonate section beneath the Eucla Shelf (Fig. 7). It is that record which should contain the answers that will allow us to link the oceanic and shelf records. What is urgently required is to determine the actual eustatic history of this basin, to in turn test and refine the more universal model. Furthermore, as outlined in COSOD II, "...it would be prudent to focus the continental margin array on three intervals of time in which coastal onlap curves have suggested major sealevel events: mid-Miocene, mid-Oligocene and early Eocene". The Eucla Shelf would seem to have the ideal sections to provide appropriate data to clarify the sealevel curve for these particular intervals.

Specifically, the southern Australian neritic shelf record appears to be at odds with the global model (Haq et al., 1987) during several critical periods. Is this because the sediments were deposited in cool-water? The Eocene sequence is now reasonably well understood onland (McGowran and Beecroft, 1986; McGowran, 1989), and is presently resolvable into three third-order sequences (locally called the Wilson Bluff, Tortichilla and Tuketja transgressions) that do not currently fit the global model (Fig. 4). More critical, however, is the Oligocene sequence. Although the Terminal Eocene Event is recorded by a major sealevel fall, the match between the global model and the preserved Oligocene succession is poor. Early Oligocene strata, deposited during what should be a highstand, are absent in the onshore Eucla Basin. The postulated mid-Oligocene fall in sealevel, furthermore, is nowhere recorded, as sedimentation appears to have either been continuous, or in some cases to have begun during the middle Oligocene. The southern Australian margin, apparently containing a detailed shelf to abyssal plain record, would appear to have exactly the right succession of limestones to yield a sealevel curve with great accuracy and fidelity and to potentially resolve these problems.

By using a combination of physical stratigraphy and proxy paleoenvironmental parameters, in a much more expanded section than exists onshore, the well-preserved early to middle Miocene record will permit a thorough testing of this part of the sealevel curve and resolution of specific eustatic events (Wright et al., 1992). The late Miocene to Pliocene sequence is unknown onshore except for the Early Pliocene highstand, and so this will be the first clear record of this component of the sealevel record in this region.

Eustacy and carbonate platforms: Carbonate platforms, with their chemically metastable sediments born largely in place, are particularly responsive to changes in seawater temperature and chemistry and variations in sea state and sealevel. To date, most information on carbonate platforms comes from rimmed, warm-water platforms (Kendall and Schlager, 1981; Sarg, 1988). There is almost no information on the manner in which cool-water carbonate platforms respond to changes in these critical parameters at a variety of different time scales. Specifically, we require information describing how different segments of the shelf react during different parts of the sealevel cycle. **Drilling the Great Australian Bight transect should permit the first detailed analysis ever of such process-response questions within a cool-water carbonate platform environment.**

There is considerable debate, for example, as to how the cool-water platforms respond during sealevel falls (Driscoll, et al., 1991; Schlager, 1992); is there production of a succession of wedge-shaped sediment packages (platform margin systems tracts), or is there overall exposure as is the case for warm-water platforms? Is there across-shelf transport of terrigenous clastics? Is there really extensive lowstand shedding? What is the nature of the resultant unconformities (how much is due to subaerial exposure; how much to subsequent ravinement processes?).

It is also far from clear how such platforms respond at times of sealevel rise and rapid production of accommodation space. Theoretically, the answer should be a function of the relationship between the rate of sealevel rise and the rates of sediment production and offshore transport under different sea states. However, there is no consensus on the nature of transgressive systems tracts sediments . Is this the time of maximum shedding, as suggested by Holocene shelf successions? Or is this the time when downslope biogenic mounds are initiated and achieve their greatest relief, as suggested by seismic records?

The sedimentary record during highstands is particularly important because we do not know whether platforms are prevented from accreting to sealevel by the high-energy sea state or whether, as with warm-water platforms, the carbonates grow to sealevel and prograde basinward. Is there a partitioning of facies into shelf-margin and strandline components, with a wide area of intervening hardgrounds, as suggested from exposed onshore sequences?

Finally, as suggested by ODP results from northeast Australia, do cold- and warm-water carbonate platforms have basically different depositional geometries, as a result of the different ways the carbonate factory responds to sealevel changes?

THEME 4: "The Great Australian Bight drilling transect presents an opportunity to characterise fluid circulation and diagenetic processes in cool-water carbonates".

1.4 DIAGENETIC PROCESS AND FLUID CIRCULATION OBJECTIVES

1.4.1 Fluid circulation in cool-water carbonate platforms

An appreciation of the mechanisms, rates, and distribution of fluid circulation through carbonate platforms and reefs is critical to the understanding of diagenetic processes (Buddemeier and Oberdorfer, 1986). Fluid circulation has the ability to chemically alter the mineralogical composition of sediments by converting metastable minerals such as high-Mg calcite and aragonite to more stable calcite and dolomite (Mullins et al., 1984; Simms, 1984). Fluid flow can also alter the sedimentary structures and porosity of a deposit. The existence of fluid flow has been described in tropical carbonate platforms such as the Great Bahama Bank and the Queensland Plateau (Melim et al., 1994; Elderfield et al., 1993) yet, the mechanisms causing this flow are neither well documented nor understood. Of the possible mechanisms which have been advanced to explain fluid flow through carbonate platforms, we suggest that those resulting from density (buoyant circulation and reflux) and temperature differences are likely to be the most important in this cool-water carbonate environment. Although fluid flow in tropical carbonate deposits has been studied, little is known of this circulation in carbonate shelves, especially those with the high intergranular porosity and permeability of cool-water carbonates. In addition, the fact that the cool-water carbonates of the Great Australian Bight are dominantly composed of calcite, and not of the metastable carbonate minerals characteristic of tropical carbonates, means that the models used to describe and predict fluid-induced diagenetic changes in warm-water carbonates are unlikely to be applicable here. We suggest that it is vitally important to understand and model diagenetic effects resulting from fluid circulation in cool-water deposits.

The Eucla Shelf is one of the few modern shelves where the onshore recharge zone is an areally vast, flat-lying karst (the Nullarbor Plain). Most shelves border a mountainous or terrigenous clastic coastline. The proposed transect presents an opportunity to determine the flow characteristics of a shelf bordered by a low, flat carbonate hinterland. This objective is of considerable geological importance because similar situations were common during sealevel lowstands in the earlier Phanerozoic, especially bordering epeiric seas.

At present, groundwater enters the subsurface of the Nullarbor Plain via cracks and fissures in calcrete-limestone outcrops. It then percolates down into the underlying carbonate. Because of the highly porous nature of these carbonates, the water table is a nearly flat surface with a very low seaward gradient. Dating of groundwaters from the Nullarbor Plain shows that these waters are more than 50 years old (Julia James pers. comm.), indicating that the low gradient results in sluggish fluid circulation. As a result, temperature and/or density differences may be the major fluid flow driving force. It is also possible that there may be hydraulic head differences, and thus fluid flow, as a consequence of currents impinging on the continental margin, as is believed to occur in parts of the northeast Australian continental margin along the Great Barrier Reef (Marshall, 1986). Temperature, density, and hydraulic head differences are likely to have varied with time as the geometry of the carbonate sequences changed, both due to the facies type and as result of sea level fluctuations. As a results, fluid circulation patterns will have to be inferred from diagenetic changes in the rock record.

In order to study fluid flow in the sediments in the Great Australian Bight, we propose to sample unconsolidated sediments which lie adjacent to porous carbonate deposits (particularly at Site GAB-10). We suggest that these sediments may record fluid recharge and/or discharge out of the platform carbonates. This flow will be reflected as a deviation from a steady state profile of chemical constituents, such as calcium and strontium, in the pore waters. If there is no fluid flow, pore water profiles are determined by diffusion and recrystallization processes in the sediments. If there is fluid flow out of the sediments, this would be indicated by a pore water profile which is concave upwards, whereas fluid moving into the formation will be shown by a concave down profile. Further chemical measurements on these waters may provide an indication of age ($^{87}Sr/^{86}Sr$) and source ($\delta^{18}O$) of the waters.

1.4.2 Diagenetic processes in cool-water carbonate platforms

Our understanding of early carbonate diagenesis (Choquette and Pray, 1970) comes largely from inference from the older rock record (Tucker and Wright, 1991); from uplifted, exposed, Cenozoic, warm-water limestones; and from the few modern carbonate platforms that have been drilled (e.g., ODP Legs 101 and 133). To make these processes better understood and more predictable, greater information is needed from carbonate platforms which are extant, still accreting in their environments of growth, and not subject to alteration in the modern meteoric realm as is the case with those drilled off the west Florida Shelf, the Bahamas, and the Great Barrier Reef. Of these, only the last two have been intensively studied in terms of carbonate sediment diagenesis.

The Eucla Shelf differs from the latter two warm-water carbonate platforms in important ways; 1) it is tied to a continent and therefore connected to continental subsurface waters; 2) the climatic regimen changed from wet to arid during growth; 3) the shelf was covered and variously filled with cool- to cold-marine waters during its history, especially in shallow shelf environments; and 4) because of margin geometry (a relatively open shelf to ramp), third-order and higher sealevel fluctuations would have exposed only parts, and not the entire shelf. Most important, however, is that, except perhaps for short periods, the sediments were dominantly bioclastic in origin and composed of calcite minerals (calcite with various amounts of magnesium), as opposed to the metastable mineralogy of tropical carbonates. Calcitic sediments undergo little textural but profound chemical change when exposed to meteoric waters (Reeckmann, 1979; James and Bone, 1989). However, their fate, when in prolonged contact with marine waters and mixed marine and continental waters, is still poorly understood.

The subaerially exposed inner platform Cenozoic carbonates confirm that seafloor lithification by precipitation of intermediate Mg-calcite cement does occur (James and Bone, 1992), but is localised to omission surfaces and hardgrounds which are ubiquitous in inner platform sequences. We do not know the importance of such cementation in offshore Cenozoic cool-water settings because the edge is never exposed. Does such cementation, if present, extend to the upper slope? If, as seismic records suggest, there are upper slope and deep outer shelf biogenic mounds, it is critically important to ascertain if these are lithified in the same way as comparable Paleozoic counterparts (James and Bourque, 1992).

Exposure of cool-water carbonates to meteoric fluids, while partially altering the chemistry and large scale structure of the original sediments onshore, has left the small-scale fabric of the sediments intact. Since they have been subaerially exposed since Mid-Miocene time, we have no idea of the rates of such alteration. The geometry of the Eucla Shelf sediment packages offers a unique opportunity to monitor such diagenetic changes; 1) onshore, where the sediments are subject to prolonged exposure; 2) on the inner shelf, where Cenozoic carbonates are exposed primarily to seawater pumping alternating with periods of subaerial exposure; and 3) on the outer shelf and slope, where a thick Neogene package is flushed by circulating seawater. There is the additional possibility that meteoric waters exiting the shelf edge may result in carbonate dissolution and erosion as occurs on the Yucatan Peninsula (Hanshaw and Bach, 1980).

Alteration of carbonate sediments to dolomite has been significant in both the Bahamas (Varenkamp et al., 1991) and the carbonate platforms of northeast Australia (McKenzie et al., 1993). Recent studies have shown that carbonate sediments off northeast Australia were dolomitized by multi-generational fluids flowing through the platforms (McKenzie et al., 1993). In the Bahamas, the processes of dolomitization are interpreted to have been different, but were always dominated by reactions with seawater modified in various ways. But these are the only two cases, and other examples are needed if actualistic models are to be formulated. The exposed, onshore, Cenozoic cool-water carbonates across southern Australia are locally intensively dolomitized (James et al., 1992). Although these sucrosic, Ca-rich dolomites, with high porosity and permeability, are similar to those formed in deep burial settings, they are clearly near-surface phenomena. Basal plugs from vibrocores on the Eucla shelf confirm that the Eocene Wilson Bluff Limestone is dolomitized (Feary et al., 1993; James et al., 1994), and so we know that at least part of the section has been altered. The questions are: 1) is the style of dolomitization similar to that of, warm-water carbonate platforms, despite the fundamental differences in mineralogy of the two carbonate types; 2) is dolomitization more common in specific sediment lithotypes; 3) is dolomitization more intensive on the platform than in slope sediments; and 4) is dolomitization temporally constrained as it seems to be elsewhere?

THEME 5: **"The Great Australian Bight drilling transect offers the opportunity for pioneering analysis of the Cenozoic evolution of cool-water calcareous biota, with direct applicability to studies of ancient carbonate platforms presently lacking modern analogues".**

1.5 CARBONATE PLATFORM FOSSIL RECORD OBJECTIVES

Answers to some of the questions posed throughout the description of the different objectives are largely dependent upon understanding the evolutionary biology of the calcareous biota. Conversely, the data acquired through drilling will yield complementary paleontological and chemical information that will allow us to more fully decipher the paleontological record. A major objective of the COSOD II program on evolution and extinction of oceanic biota is to determine the tempo and pattern of evolution. Linked information from the neritic and oceanic high- to mid-latitude carbonate realm should produce an unmatched record of paleobiological information. Specifically, patterns and modes of speciation and diversification of coeval shallow- and deep-water benthic organisms as well as contemporaneous planktonic biota should be revealed. By comparing these results with those from Antarctica and the northeast Australian shelf, the geography of such processes and their relationship to physiochemical factors should be discernible. Are, for example, tropical species more susceptible to extinction than high latitude species? Particularly applicable will be the possibility of examining patterns of taxonomic and morphological evolution that determined the nature and composition of the biota during post-extinction recovery in the Paleocene, Oligocene and Late Miocene. The proposed drilling transect will also enable us to address other specific paleobiological problems. For example, the Oligocene appears to have been a time of gradual taxonomic change of deep ocean faunas, despite being one of the most significant periods of continental ice buildup with a correspondingly dramatic sealevel fall - is the gradual taxonomic change also a characteristic of the neritic and transitional realms? Furthermore, the deep ocean record shows that there were an unusual number of extinctions and a high faunal turnover of both planktonic foraminifers and diatoms in the early Middle Miocene and earliest Late Miocene, along with major extinctions at the Miocene -Pliocene boundary (Cita and McKenzie, 1986) - is this also the case for shallower-water biotas?

Although not one of the priorities of the ODP mandate (COSOD II), the potential results from the proposed transect are also of profound importance for interpreting the older Phanerozoic and Proterozoic rock record. In the same way that discoveries of massive sulphides and revelation of ocean crust processes have practical implications far outside the modern ocean, an understanding of the processes involved in the birth, growth and development of cool-water, open-shelf carbonate platforms is fundamental for the interpretation of at least half the platforms in the global geologic record. As there are no other modern analogues for such platforms, our understanding of the carbonate world is dominated by warm-water platforms; in other places where there are cool-water structures, they are typically overwhelmed by terrigenous clastic sediments.

Unrimmed platforms are most abundant in rocks of Cambro-Ordovician, Mississippian, Pennsylvanian, Permian, and Cretaceous age (Wilson, 1975; Tucker and Wright, 1991). The similarities between Cenozoic cool-water and Paleozoic carbonate sediments are particularly striking. The composition of many Ordovician and Mississipian subtidal shelf carbonates, both in terms of biota and mineralogy, is amazingly similar to Cenozoic cool-water shelf carbonates, consisting of sediments dominated by bryozoans, brachiopods, echinoderms, and solitary corals, and with dominantly calcite mineralogies. In addition to sharing these attributes, the Eucla Platform is a particularly ideal model for these older carbonates, as; 1) the shelf lies adjacent to a vast karst, like many Paleozoic cratonic miogeoclines and epeiric seas; 2) the outer shelf and slope downlaps onto the Eyre Terrace, at depths of ≈1000 m, unlike most modern shelves which face abyssal depths, and so has the attributes of a shelf bordering an intracratonic basin; 3) the succession, although mostly cool-water, contains intervals of warm-water carbonate; and 4) seismic data suggests the presence of upper slope and shelf-edge biogenic mounds, a recurring component of Paleozoic ramps and open shelves (James and Bourque, 1992).

2. GEOLOGICAL BACKGROUND

2.1 Tectonic Setting of the Great Australian Bight

The southern margin of the Australian continent is a divergent, passive continental margin that formed during the protracted period of extension and rifting that led to the separation of Australia and Antarctica in the Cretaceous, and evolved during the subsequent northwards drift of the Australian continent (Fig. 8). Continental extension began in the Jurassic, with lithospheric extension of about 360 km on a SE azimuth (Etheridge et al., 1984; Willcox et al., 1987; Etheridge et al., 1988). This was followed by breakup in the mid-Cretaceous (96 Ma), and slow spreading until the middle Eocene (49 Ma), on an azimuth of 335°. Subsequent accelerated spreading in the middle Eocene (until 44.5 Ma), and then faster spreading to the present, were both on an azimuth of 360° (Veevers et al., 1990; Fig. 9).

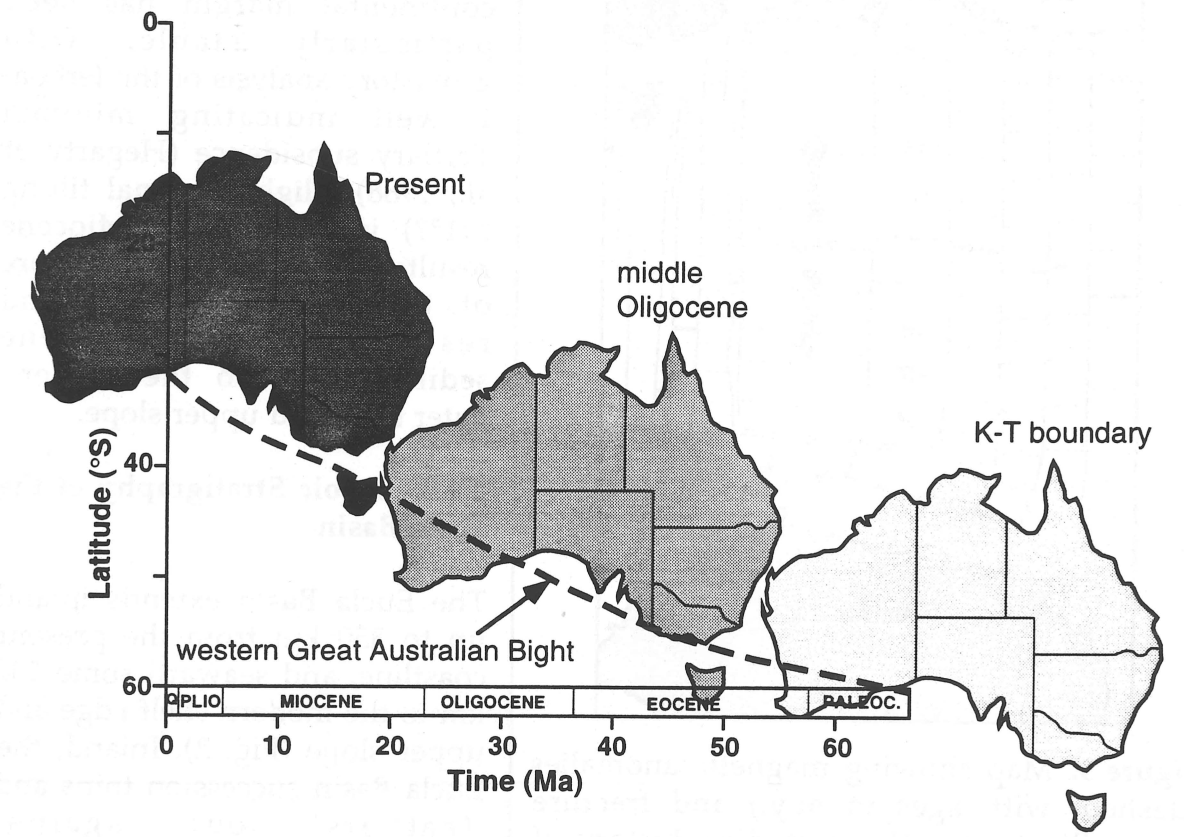


Figure 8. Northward movement of the Australian continent throughout the Cenozoic, based on hot spot and paleomagnetic data (Duncan, 1981; Wellman, 1983; Idnurm, 1985, 1986). The heavy dashed line shows the paleolatitude track of the western Great Australian Bight.

The initial extension phase prior to breakup, together with the following period of slow spreading, resulted in deep continental margin basins filled with up to 12 km of mainly terrigenous clastic sediments (Willcox et al., 1988; Davies et al., 1989). These basins broadly correspond to the sites of modern upper slope terraces (e.g., the Eyre Terrace at 400-1600 m depth in the western Great Australian Bight; Fig. 1). The onset of faster spreading in the middle Eocene also corresponded with establishment of fully marine conditions, and initiation of carbonate sedimentation in the widening 'gulf' between Australia and Antarctica. Carbonate sedimentation continued throughout the remainder of the Cenozoic, as the gulf evolved first into a broad, open seaway, and then into the modern Southern Ocean. Cenozoic sedimentation resulted in an extensive, relatively thin (up to 800 m thick; Feary and James, in press) Eucla Basin succession deposited in a predominantly platform-sag to platform-edge tectonic regime (Stagg et al., 1990).

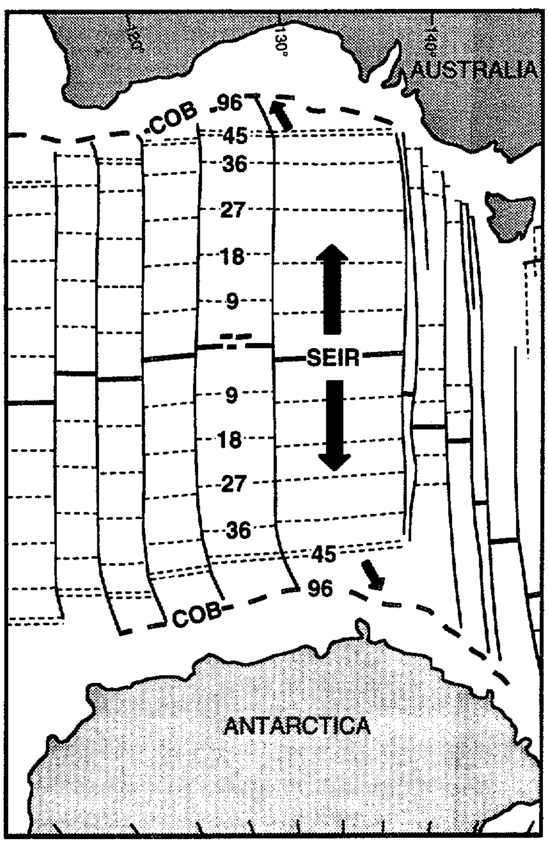


Figure 9. Map showing magnetic anomalies (dashed; with ages in m.y.) and fracture zones, illustrating the spreading history of the Southeast Indian Ridge (SEIR) and development of the Southern Ocean south of Australia. Based on Veevers (1990) and Veevers et al. (1990). The direction and rate of spreading is shown by infilled arrows. COB = continent-ocean boundary.

Throughout the Cenozoic, the western Great Australian Bight portion of Australia's southern continental margin has been particularly stable, with geohistory analysis of the Jerboa-1 well indicating minimal Tertiary subsidence (Hegarty et al., 1988). Slight regional tilting (<1°?) in the middle Miocene resulted in uplift and exposure of the Nullarbor Plain, and restriction of Neogene sedimentation to the modern outer shelf and upper slope.

2.2 Cenozoic Stratigraphy of the Eucla Basin

The Eucla Basin extends inland up to 350 km from the present coastline, and seaward some 200 km to the modern shelf edge and upper slope (Fig. 2). Inland, the Eucla Basin succession thins and 'feathers' out against Precambrian basement; it gradually thickens southwards to be thickest beneath the modern shelf edge (Fig. 10). Apart from the basal siliciclastic sequence both offshore (Sequence 7; see below) and onshore (Hampton

Sandstone; see below), and a thin, trangressive, paleovalley- filling and strandline succession of terrigenous clastics on the inland margins of the basin, the Eucla Basin succession is entirely carbonate. The seismic stratigraphy of the offshore Cenozoic succession and the onshore facies and stratigraphy are first described separately, and then we infer the correlation between offshore and onshore components of the Eucla Basin succession.

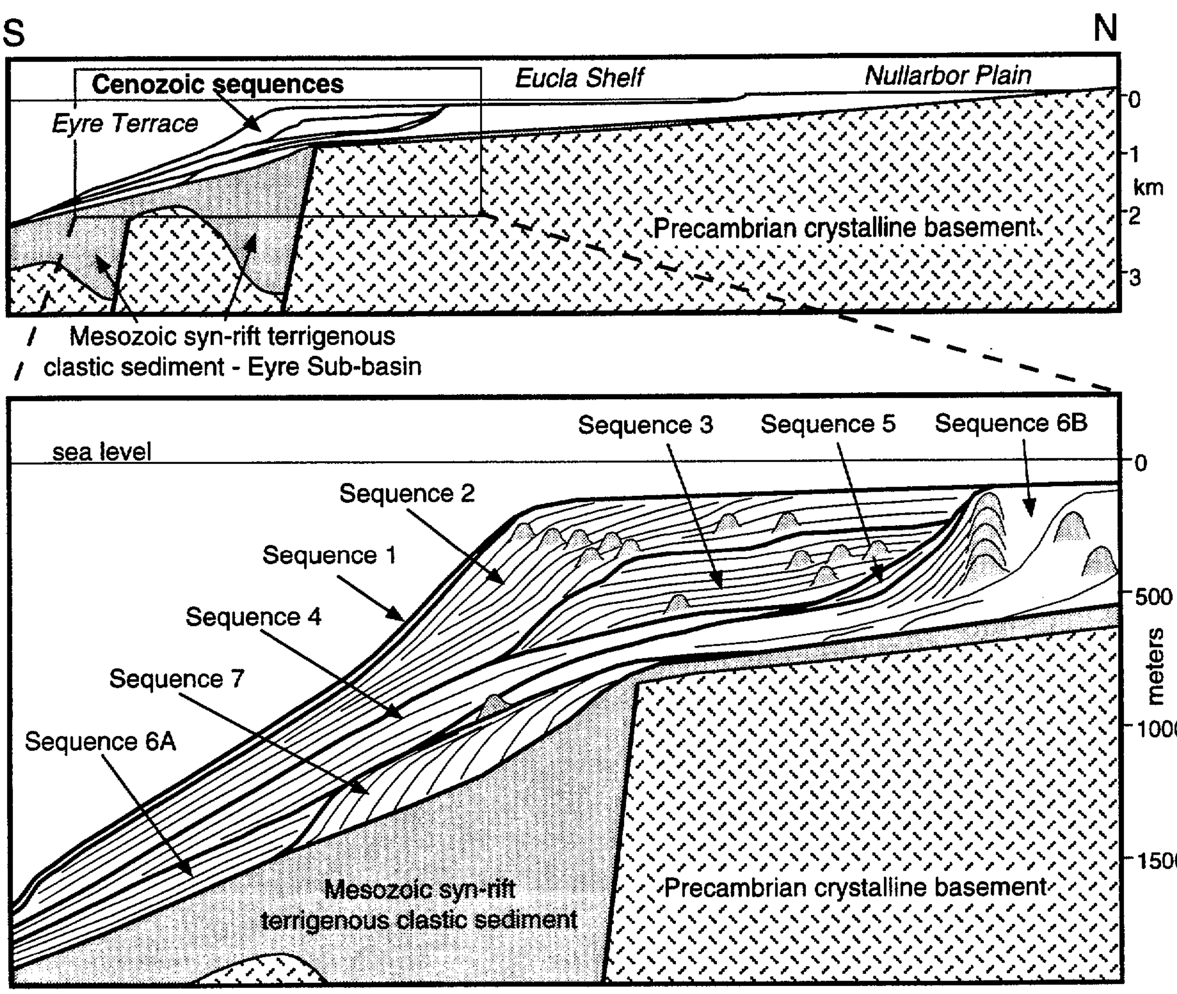


Figure 10. Schematic N-S diagram from the Nullarbor Plain to the upper continental slope, across the Eyre Terrace (along longitude 128°E), showing the distribution and internal relationships of seven Cenozoic sequences (unshaded) defined from seismic data, overlying Mesozoic syn-rift siliciclastic sequences and Precambrian crystalline basement (after Feary and James, in press). Note the distribution of biogenic mounds within many of the Cenozoic sequences, and the stacked reefs within Sequence 6B. Vertical scales are approximate.

2.2.1 Offshore Stratigraphy

The offshore succession is basically divisible into 2 mega-sequences; a Mesozoic

(?Late Jurassic-Cenomanian; Stagg et al., 1990) siliciclastic-dominated syn- to early post-rift section and a Cenozoic (Paleocene to Recent), predominantly carbonate-dominated section, separated by a major, basin-wide unconformity. The subject of the bulk of this proposal is the upper succession, which makes up an overall sigmoid-shaped series of sequences reaching a maximum thickness beneath the present-day outer shelf (Fig. 10). Because of the relatively simple subsidence history of much of this margin, the present-day inner shelf succession represents Paleogene to earliest Neogene inner shelf deposition; the present-day outer shelf succession represents later Neogene outer shelf deposition overlying Paleogene outer shelf and shelf-edge deposits; and the present-day upper slope succession represents Neogene and Paleogene upper slope deposition. The stratigraphy of the lower, Mesozoic succession is based on the sequence intersected in the Jerboa-1 exploration well (see Section 3.2.1); however little information on the upper, Cenozoic section can be obtained from this hole.

The extensive erosional unconformity at the top of the syn-rift section forms an easily recognisable and mappable surface. On the basis of the high quality seismic data which forms the basis of this proposal, seven unconformity-bounded seismic sequences have been recognised overlying this unconformity. One of the most striking elements of this seismic stratigraphic analysis is the identification of numerous mound-shaped structures, occurring throughout the Cenozoic succession, which we have interpreted as biogenic mounds (Feary and James, in press). These structures are likely to preserve a detailed record of cool-water faunal community relationships, and potentially provide an analogue for cool-water mounds recognised in the rock record, but for which no modern analogues have previously been identified.

The dates assigned to this succession are extremely tentative, and are based on correlation of Sequence 6B with the onshore Eucla Group (see Section 2.2.3); on the similarity in depositional style between the Sequence 7 progradational wedge and ?Paleocene-Early Eocene progradational sequences elsewhere along Australia's southern margin; and the division of the remainder of the sequences into a reasonable time stratigraphic framework. The seven Cenozoic sequences are briefly described in stratigraphic order:

Sequence 7: Early Paleogene (?Paleocene-Eocene) progradational siliciclastic wedge sequence. This sequence is an approximately east-west-oriented elongate sediment body (Fig. 11), which occurs immediately seaward of a large basement high to the northeast, and thins out against this high. The wedge thickens seaward to its thickest part (up to 230 m thick), and then abruptly downlaps onto the underlying unconformity (Fig. 10). In some places, there is a very thin sediment apron in front of the clinoform front. Internal reflectors show a pronounced clinoform geometry, indicating that the sequence was deposited by dominantly south-directed progradation. This sequence is inferred to be an entirely siliciclastic succession, derived by erosion of Precambrian basement. In some places, reflectors are disrupted by volcanic intrusions, in most cases apparently related to leaky basement faults, which extrude along the top of this sequence. Sequence 7 deposition was controlled by the interaction of southward-directed sediment supply with both depositional base-level (constraining the sequence top) and tectonic sag and compaction of the Eyre Sub-basin rift succession (providing the accommodation space).

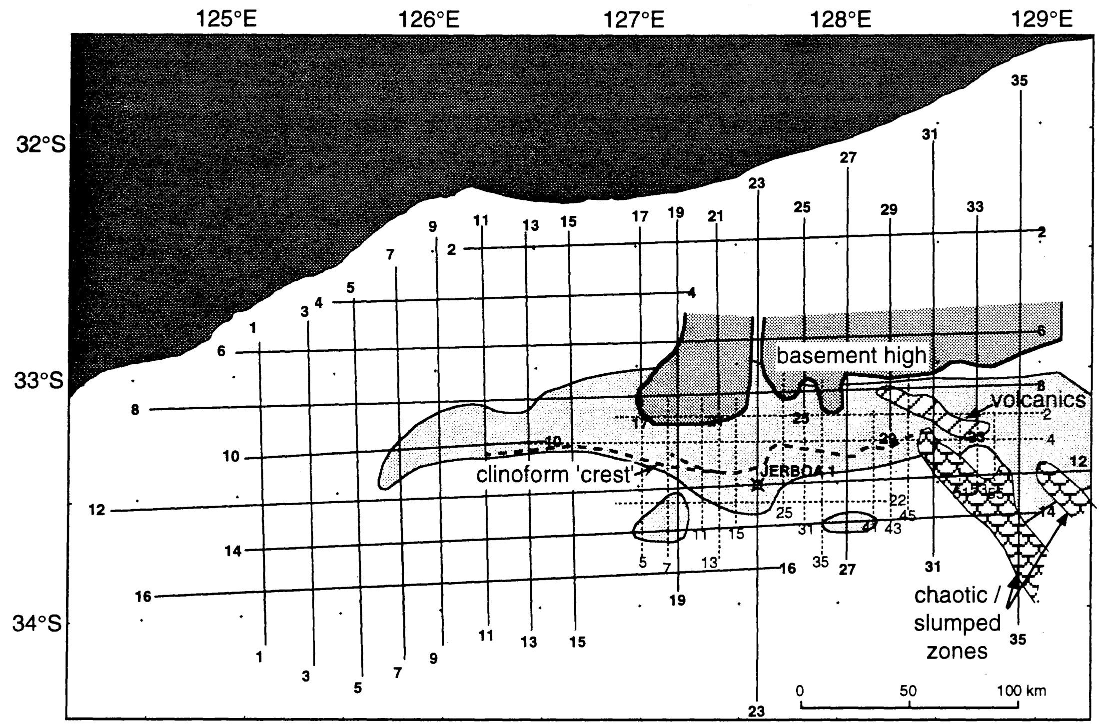


Figure 11. Distribution of the Sequence 7 wedge. The dashed 'clinoform crest' marks the location of the youngest part of this sequence.

Sequence 6A: Paleogene-Early Neogene (?Middle Eocene to ?early Middle Miocene) lobate carbonate sequence. This is a relatively thin sequence (up to 195 m) which occurs underlying the present-day Eyre Terrace. It occurs seaward and at a lower elevation compared with the Sequence 6B progradational carbonate shelf sequence, but it appears to be broadly coeval with that sequence (Fig. 10). It is comprised of three overlapping sediment lobes (Fig. 12), separated by unconformities, which in most places onlap landward against the Sequence 7 siliciclastic wedge. It is characterised by a relatively coherent reflector character and few, generally small mounds.

The component of this sequence intersected at Jerboa-1 consists of calcilutites and marls (Huebner, 1980); accordingly we infer that these lithofacies are probably representative of this sequence. We infer that Sequence 6A was either derived by erosion of Sequence 6B limestones during sealevel lowstands, or is a distal, pelagic equivalent of Sequence 6B.

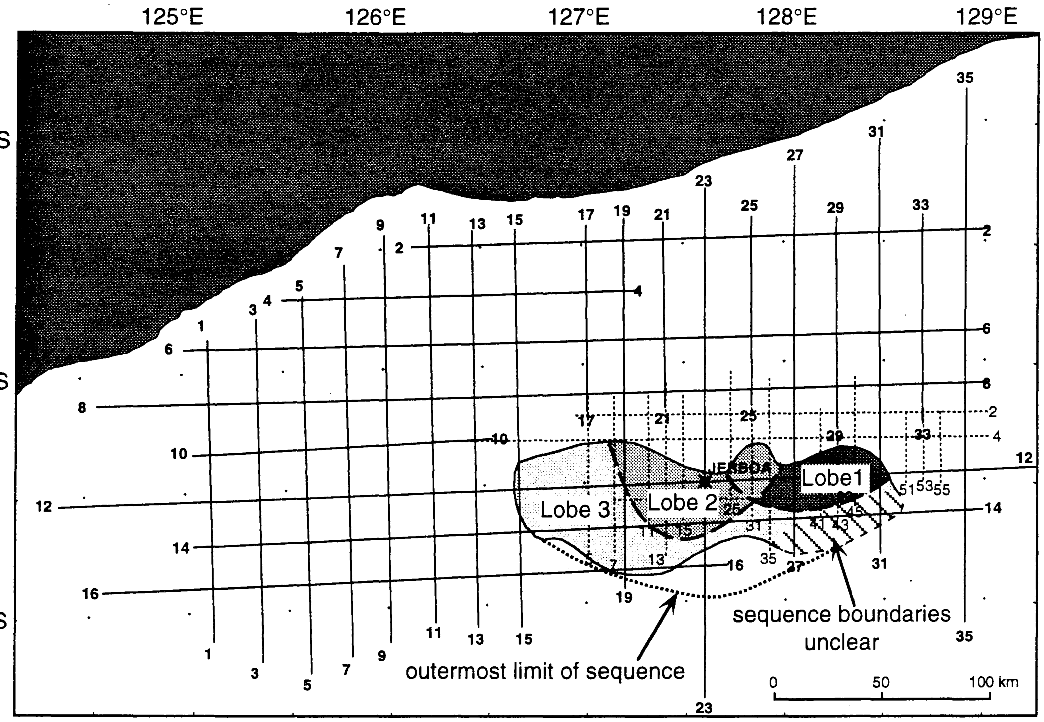


Figure 12. Distribution of the three Sequence 6A sediment lobes. Lobe 1 is oldest, and the widely distributed Lobe 3 is youngest.

Sequence 6B: Paleogene-Early Neogene (Middle Eocene to early Middle Miocene) progradational carbonate shelf sequence; the Great Australian Bight "Little Barrier Reef". This is the most extensive (and geometrically most dramatic sequence) within the Cenozoic succession. It makes up the entire Cenozoic succession beneath at least the inner half of the present-day shelf, and we infer (see Section 2.2.3) that it correlates with the carbonate component of the Eucla Group exposed onshore (i.e., Wilson Bluff Limestone, Abrakurrie Limestone, and Nullarbor Limestone).

The distribution of this sequence essentially corresponds to the area of the present-day broad continental shelf, some 100-300 km wide (Fig. 13). The sequence can be areally divided into three components: an inner shelf portion; an escarpment zone; and an outer shelf portion. The sequence makes up most or all of the sedimentary succession within the inner shelf zone, either directly overlying basement, or unconformably overlying a relatively thin Mesozoic succession in areas of lower basement. The escarpment zone is a thick (400-450 m), relatively narrow band where the top of this sequence abruptly dips from close to or at the present sea-floor, more than 250 m into the sediment pile (Fig. 10). A much thinner component of this sequence (up to 170 m thick) extends seaward below the present outer shelf from the base of the escarpment to near the position of the present shelf edge, where it wedges out by downlap onto the underlying unconformity.

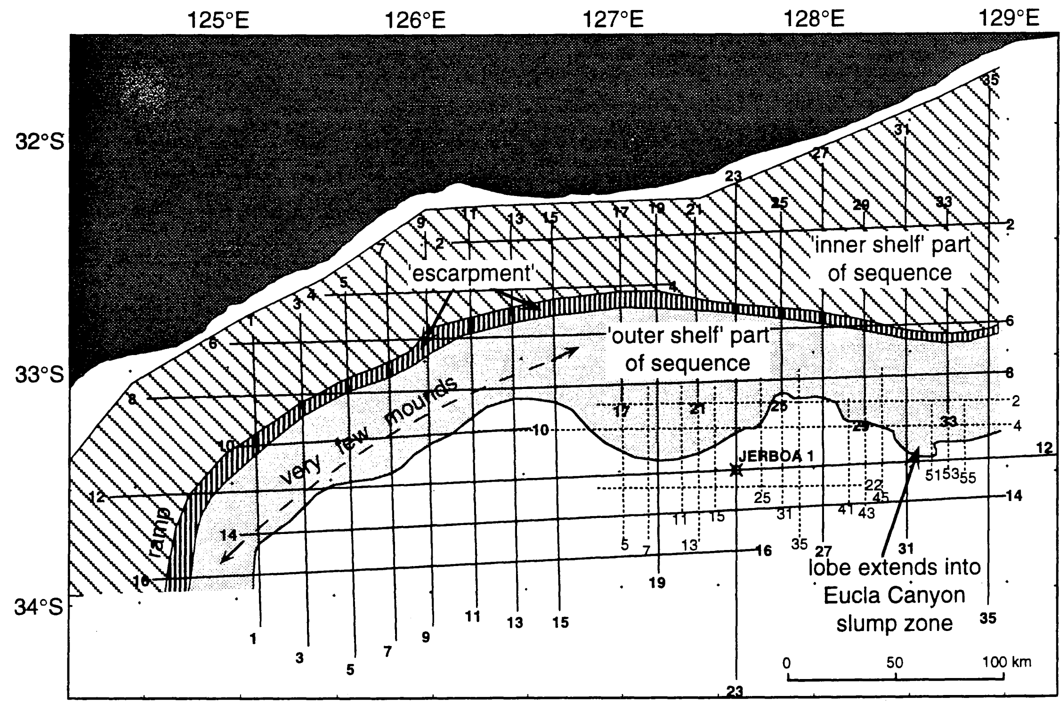


Figure 13. Distribution of Sequence 6B, showing the division into 'inner shelf', 'escarpment', and 'outer shelf' zones. The 'escarpment' zone beneath the middle modern continental shelf marks the position of the inferred early Middle Miocene "Little Barrier Reef".

There is a broad clinoform structure within the inner shelf zone, with older parts of the sequence occurring closer inshore. Clinoforms range from gently-dipping, almost planar ramps to much more steeply-dipping sigmoidal surfaces. Biogenic mounds occur throughout the inner shelf (ramp) zone. A zone approximately 8-10 km wide immediately landward of the escarpment top is marked by an abundance of relatively large reefs, with high amplitude capping reflectors indicating more strongly cemented surfaces. This reefal escarpment has been described as the Great Australian Bight "Little Barrier Reef" (Feary and James, submitted). The outer shelf zone is comprised of evenly-bedded reflectors and a minor carbonate mound component.

Reflector geometry indicates that deposition of this sequence was largely a function of the balance between relative sealevel movement and organic growth capability.

Sequence 5: Neogene (?Middle-Late Miocene) debris apron sequence. This sequence is a small sediment wedge with restricted distribution, lying at the foot of the steepest part of the progradational carbonate shelf escarpment zone in the eastern part of the area (Fig. 14). Sequence 5 reflectors onlap against the steepest part of the Sequence 6B escarpment, and downlap onto the prominent unconformity forming the top of the Sequence 6B outer shelf zone (Fig. 10). The location and geometry of this sequence indicates that it is largely or totally composed of material derived from the Sequence 6B progradational carbonate shelf. If our inferences concerning the correlation of the youngest Sequence 6B depositional phase with the onshore Nullarbor Limestone are correct, then it is likely that this sediment wedge consists of packstone and grainstone facies containing reworked cemented carbonate and bioclastic detritus largely derived from the Nullarbor Limestone during a sealevel lowstand.

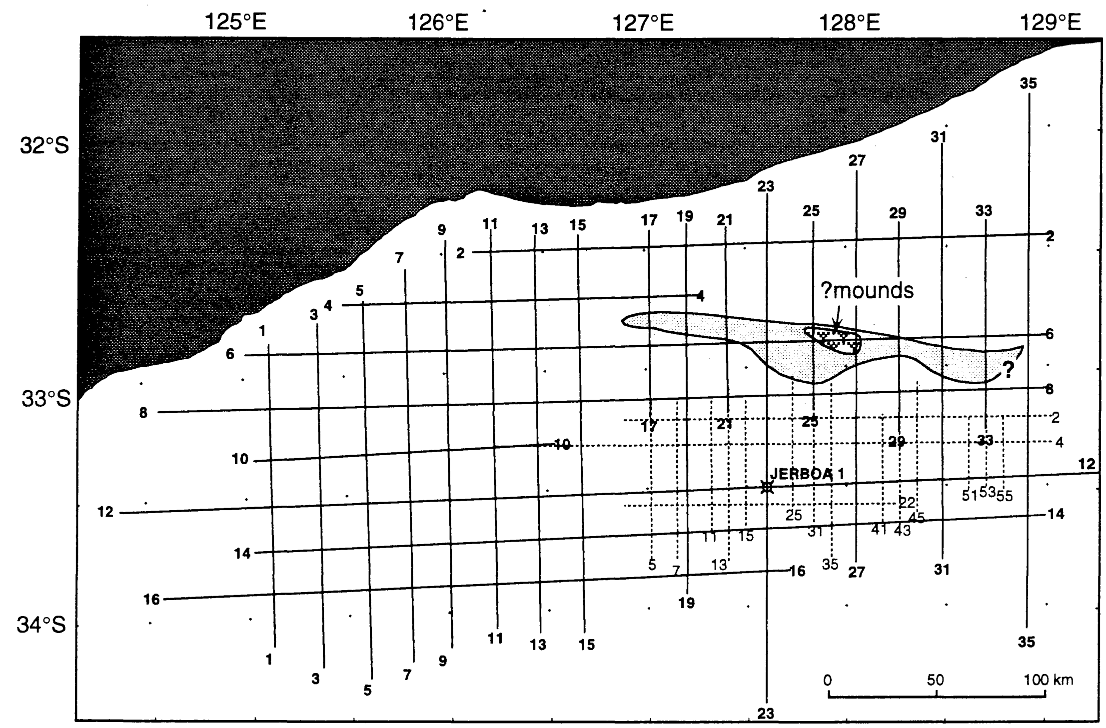


Figure 14. Distribution of the Sequence 5 debris apron, lying against the base of the Sequence 6B escarpment.

Sequence 4: Neogene (?Late Miocene-?Pliocene) aggradational deep water carbonate sequence. This sequence is a thin (less than 160 m thick) but areally extensive interval, characterised by relatively abundant biogenic mounds on many lines, occurring beneath much of the present-day outer shelf, Eyre Terrace, and uppermost slope (Fig. 15). Stratal relationships show that initial Sequence 4 deposition occurred along a relatively narrow zone immediately seaward of the toe of the Sequence 6B outer shelf zone apron. Subsequently, deposition extended landward across this outer shelf zone apron, and then extended both further seaward and towards the west. We infer that this is a dominantly carbonate sequence, made up of material derived from biogenic mounds and from input of carbonate detritus eroded from the older Sequence 6B progradational carbonate shelf. Accordingly, we infer that it is mostly comprised of packstones and wackestones, with perhaps subsidiary grainstones representing zones of higher energy nearshore.

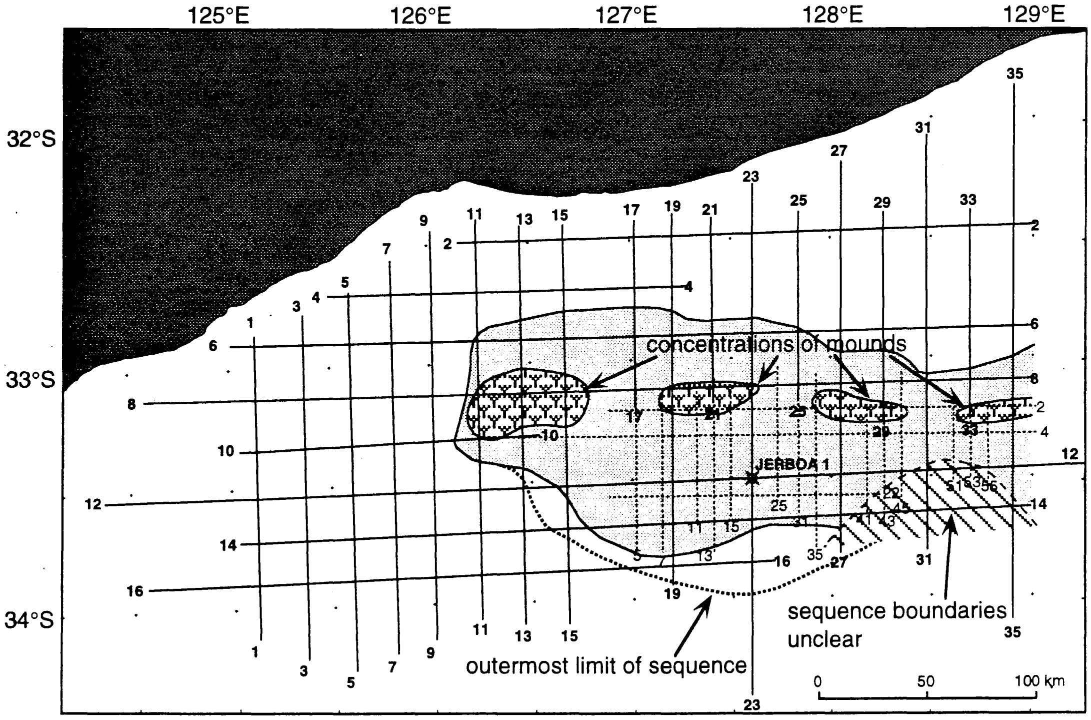


Figure 15. Distribution of Sequence 4, showing concentrations of biogenic mounds.

Sequence 3: Neogene (?Mid-late Miocene-Pliocene) aggradational shelf sequence. Sequence 3 is areally extensive (Fig. 16), underlying much of the present-day outer shelf. The sequence is thin in the west (<50 m), and reaches its maximum thickness (235 m) towards the middle of the seismic grid. The internal geometry of the sequence is dominantly aggradational, with only a minor progradational element. Internal reflectors onlap against the Sequence 6B escarpment at the landward extent of the sequence, and on some lines are abruptly truncated at the seaward edge (Fig. 10). We infer that this truncation was most probably a result of either wave abrasion or cold, corrosive current action. Sequence 3 contains abundant biogenic mounds, particularly towards the landward edge and high in the sequence. We infer that this sequence is principally composed of shelf-derived carbonates, with carbonate mounds having formed the loci of maximum carbonate production, with perhaps also a subsidiary input of carbonate detritus eroded from the older Sequence 6B progradational carbonate shelf. Accordingly, we infer, as with Sequence 4, that it is mostly comprised of packstones and wackestones, with minor grainstones perhaps representing zones of higher energy nearshore.

Sequence 2: Late Neogene (?Plio-Pleistocene) progradational shelf/shelf-edge/ upper slope sequence. This sequence is a sigmoidal-shaped unit which forms a thin succession over the outer shelf (70-90 m), reaches peak thickness at the present shelf edge (350-400 m), and thins as a wedge further seaward (Figs 10, 17).

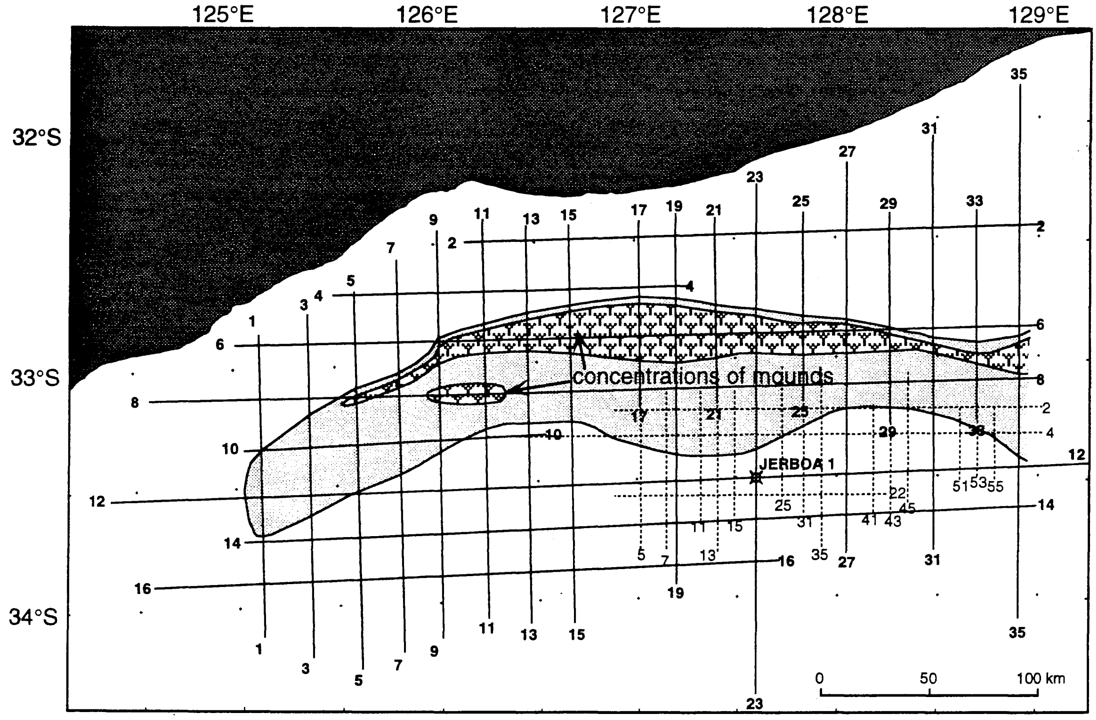


Figure 16. Distribution of Sequence 3. Note the concentrations of biogenic mounds along the innermost part of this sequence.

It includes a prominent series of biogenic mounds, in many cases forming mound complexes, marking the location of the shelf edge. Immediately seaward of these shelf-edge mound complexes, the sequence consists of prominent clinoforms. There are indications of internal unconformities within the clinoform succession, and elsewhere in the sequence, but these unconformities are not traceable with the existing seismic resolution. Internal reflectors onlap against the Sequence 6B escarpment at the landward margin of the sequence, and also onlap against the truncated outer Sequence 3 boundary further seaward. We infer that this sequence is comprised of a range of rock types, with grainstones representing higher energy shelf deposition closer to shore, grading to wackestones and packstones deposited in deeper, lower energy environments further seaward.

Sequence 1: ?Pleistocene-Holocene deeper-water drape sequence. This is an extremely thin sequence (up to 50 m) which drapes deeper parts of the margin (below 150-200 m water depth), and is inferred to be comprised of muddy carbonate facies; seismic pulse interference restricts any interpretation within this sequence.

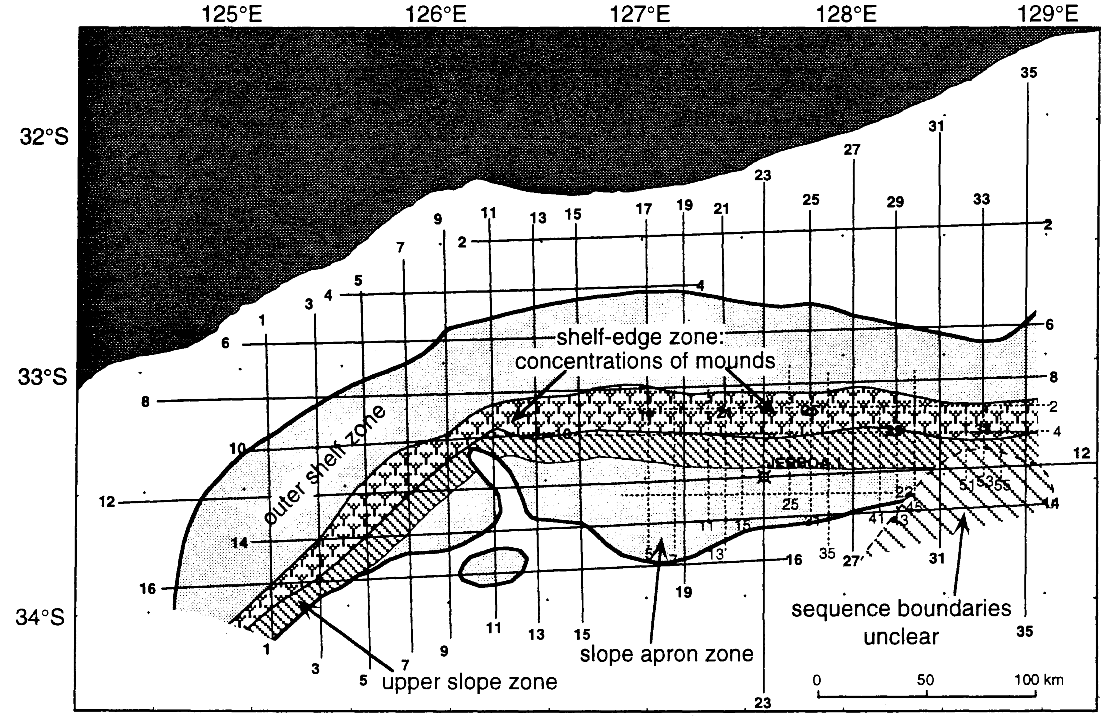


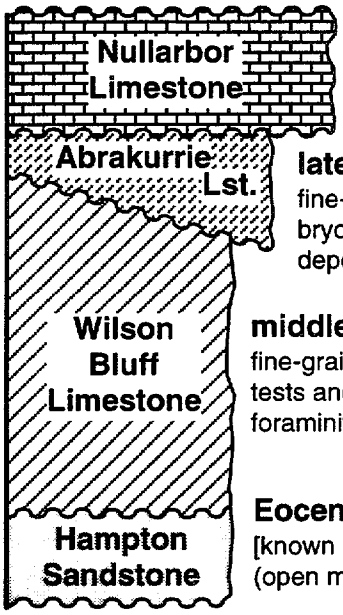
Figure 17. Distribution of Sequence 2, showing the division into outer shelf, shelf-edge (with abundant biogenic mounds), upper slope, and slope apron zones.

2.2.2 Onshore Stratigraphy

Onshore carbonates (Fig. 18) have been subaerially exposed continuously since the Middle Miocene, and the modern surface is an extensive, flat karst plateau with little vegetation. Outcrops are 100 m high, vertical to overhanging sea cliffs; low road cuts; the walls of sinkholes and caves; and the faces of shallow quarries along the Trans-Australian railway. Subsurface information is scattered, coming largely from shallow boreholes in the eastern part of the region.

Precambrian basement is overlain by a thin, siliciclastic, Cretaceous cover sequence (of Neocomian-Aptian, Albian-Cenomanian, and Senonian age), locally thick where it infills basement depressions.

The oldest Cenozoic unit is the thin **Hampton Sandstone**, estuarine to fluvial at the base, and containing marine fossils indicating a late Middle Eocene age towards the top. This is overlain by the thick **Wilson Bluff Limestone**, a medium- to thick-bedded, white, muddy, burrowed unit of Middle and Late Eocene age containing abundant bryozoans, scattered echinoid tests and spines, brachiopods, bivalves, sponge spicules, planktonic foraminifers, chert, and minor glauconite. This unit progressively onlapped farther inland, reaching its maximum extent to the margins of the Eucla Platform in the Late Eocene. The maximum thickness onshore is approximately 300 m, in the center of the basin at the present shoreline.



late early Miocene-early middle Miocene (>60 m)
well-cemented, fossiliferous skeletal unit containing large benthic foraminifers, bivalves, coralline algae, and hermatypic corals (shallow shelf deposit)

late Oligocene-early Miocene (>30 m)
fine- to very coarse-grained, poorly-cemented limestone containing abundant bryozoans and bivalves, together with echinoids and gastropods (deep shelf deposit; >70 m water depth)

middle-late Eocene (>300 m)
fine-grained chalky limestone, with abundant bryozoans, and scattered echinoid tests and spines, brachiopods, bivalves, sponge spicules, and planktonic foraminifers (deep shelf deposit; 70-100 m water depth)

Eocene (>85 m)
[known only from wells] medium- to very coarse-grained, calcareous sandstone (open marine, shelf environment)

Figure 18. Summary of the stratigraphy of the Eucla Group from onshore exposures on the western Nullarbor Plain (after Lowry, 1970, and James and Bone, 1991).

The overlying **Abrakurrie Limestone** is predominantly a coarse-grained bryozoan calcarenite that onlaps the Wilson Bluff Limestone (James and Bone, 1991), is distinctly cyclic, and contains numerous hardgrounds (James and Bone, 1992). It is a maximum of 100 m thick at the coast, where the area of deposition is 450 km wide, and extends inland a maximum of 130 km to a feather-edge. There is a general consensus that the Abrakurrie Limestone is of middle Oligocene to Early Miocene age.

The **Nullarbor Limestone** is a hard, fossiliferous, muddy limestone that ranges in age from late Early Miocene to early Middle Miocene (Lindsay and Harris, 1975; Benbow and Lindsay, 1988). This limestone has a distinctively warmer-water aspect than the underlying Abrakurrie Limestone, as reflected by ubiquitous coralline algae, numerous large benthic foraminifers, more abundant molluscs, and local concentrations of hermatypic corals. The Middle Miocene highstand which resulted in deposition of the Nullarbor Limestone was higher than the Abrakurrie Limestone highstand, and as a result the Nullarbor Limestone overlies the Abrakurrie Limestone near the coast and the Wilson Bluff Limestone inland. At the landward margin of the Eucla Platform, the widespread Nullarbor Limestone passes into a complex mosaic of strandline terrigenous and carbonate facies encompassed within the Yarle Sandstone, Gamma Island Formation, Colville Sandstone and Garford Formation. The top of the Nullarbor

Limestone is typically truncated by modern or Neogene erosion.

2.2.3 Onshore-to-Offshore Correlation

A combination of seismic geometry, seismic facies, and the relatively simple structure beneath the inner shelf and nearshore area permits a confident correlation of offshore sequences with the onshore stratigraphic succession (Fig. 19). The gently inclined 'ramp' geometry of reflectors within Sequence 6B, beneath the modern inner shelf, indicates the much of this sequence correlates with the Wilson Bluff Limestone onshore. We correlate the transition from ramp to rimmed platform geometry within Sequence 6B with the transition from cooler-water carbonates of the Wilson Bluff and Abrakurrie limestones to warmer-water carbonates of the Nullarbor Limestone (Feary and James, submitted). The seismic facies characteristics of the rimmed portion of Sequence 6B (immediately shoreward of the reefal escarpment) are in accord with this component of the sequence being more pervasively cemented, supporting the inference of a warmer-water depositional and early diagenetic environment. The inner shelf part of Sequence 6B contains several surfaces that appear to be unconformities, one of which is likely to correlate with the unconformity at the base of the Abrakurrie Limestone; however, the disruption of seismic reflectors by biogenic mounds and the wide (≈25 km) seismic line spacing precludes the confident identification of any particular unconformity. As a consequence of the overall geometry of the offshore sequences (Fig. 10), the sequences occurring beneath the present day outer continental shelf and upper slope (Sequences 1 to 5) are not present onshore. The top of Sequence 7 may correlate with the Hampton Sandstone onshore.

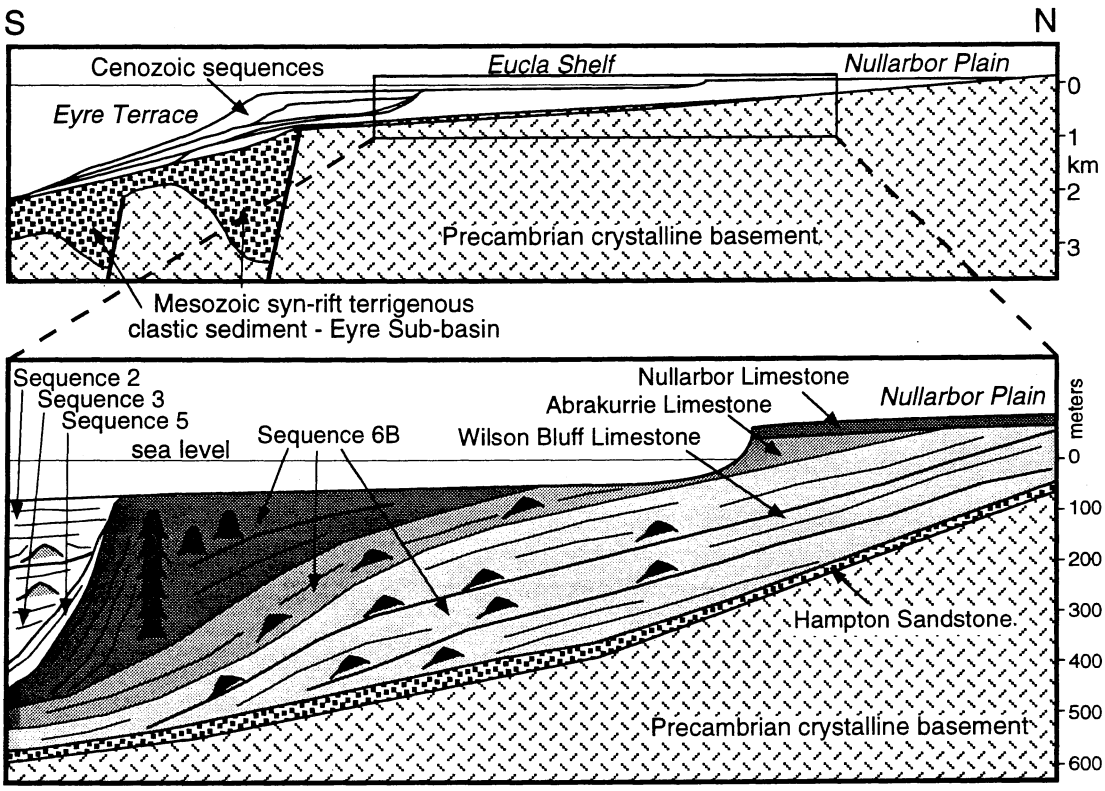


Figure 19. Schematic diagram (with considerable vertical exaggeration) showing the inferred correlation between onshore and offshore components of the Eucla Basin succession. Unconformities in the onshore succession (between Wilson Bluff, Abrakurrie, and Nullarbor limestones) cannot reliably be correlated with specific unconformities within Sequence 6B offshore; however, the inferred relationship is consistent with all available data.

3. EXISTING DATA

3.1 Seismic Data

JNOC data: This proposal is based on the detailed seismic stratigraphic interpretation (Feary and James, in press) of a grid of 2,350 km of high-quality, regional 2-D seismic lines collected and processed by the Japan National Oil Corporation in 1990/1991, over an area of 155,000 km^2 on the continental shelf and upper slope of the western Great Australian Bight (Fig. 20). An additional 1380 km of moderate-quality regional 2-D seismic lines, collected by Esso Australia in 1979 and reprocessed by JNOC, were also used to infill gaps in the JNOC dataset (Fig. 20).

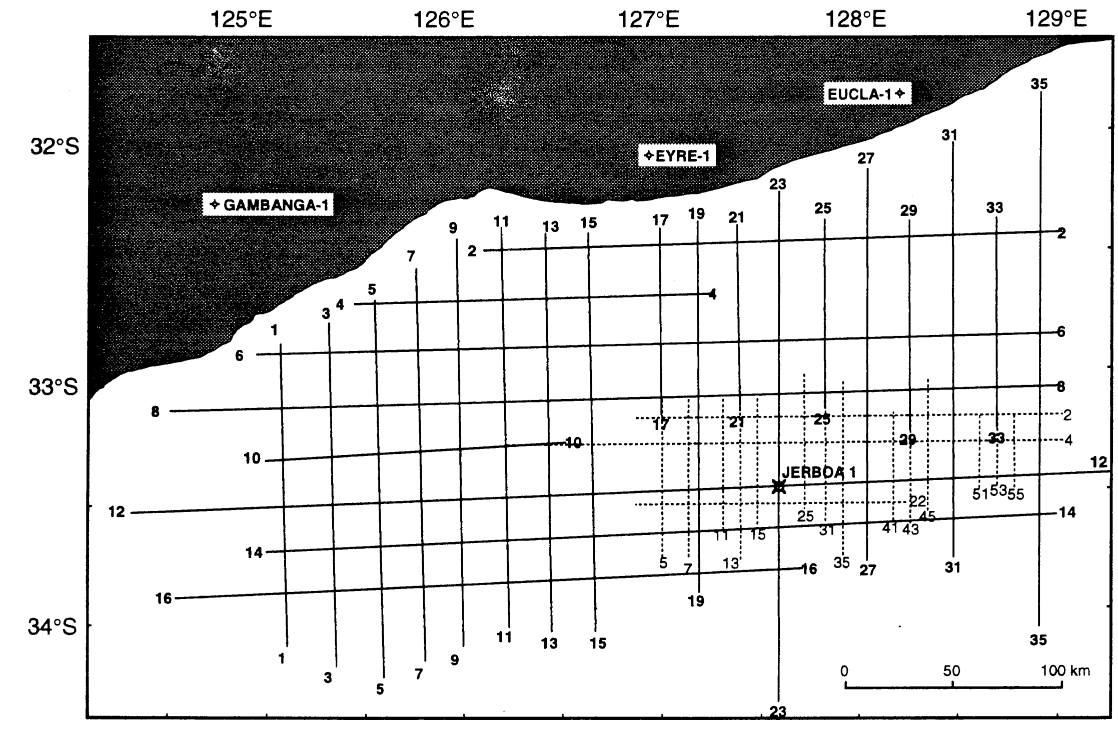


Figure 20. Map showing distribution of JNOC (solid line) and Esso E79A (dashed line) seismic tracks in the western Great Australian Bight.

Other MCS data: Shell Development Australia collected some 25,000 km of fair - to moderate-quality seismic data in the eastern Great Australian Bight (Ceduna Terrace and adjacent continental shelf) between 1966 and 1976. In addition to the 1979 survey data used in this proposal, Esso Australia also collected a detailed grid of high-quality data in the immediate vicinity of Jerboa-1 in 1982. In 1986, AGSO collected some 3,500 km of moderate-quality, 24-channel data on a series of regional lines linking the Eyre and Ceduna terraces with the continental rise and abyssal plain; these lines have been used as the basis for another ODP proposal (LOI 31 - Stagg and Willcox, 1993).

SCS data: Relatively low-quality, regional single channel lines were collected by Lamont-Doherty Geological Laboratory (1969-1976) and by the AGSO Continental Margins Survey (1972).

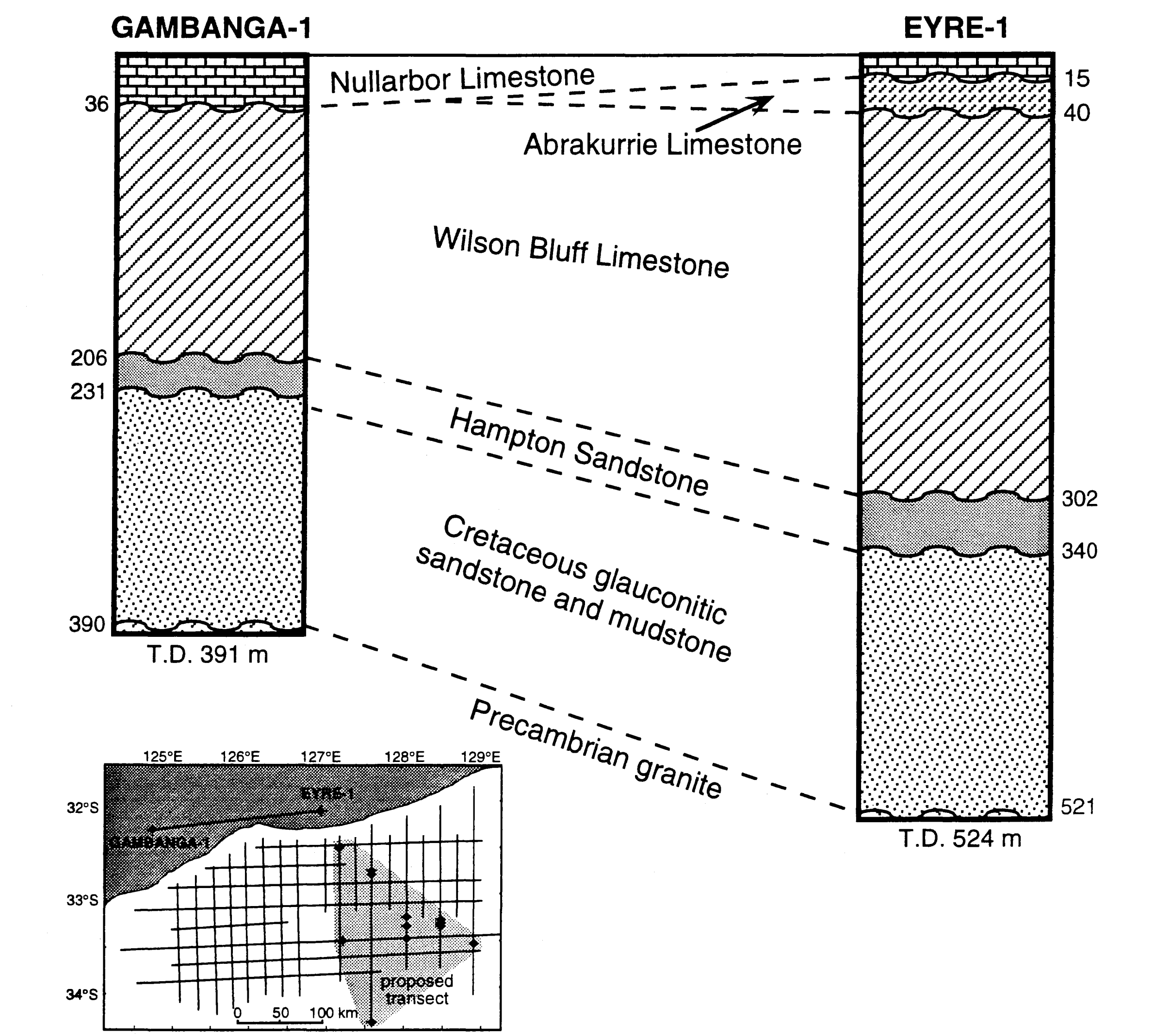


Figure 21. Stratigraphy of onshore drillholes through the Eucla Basin succession, based on well completion reports. Inset map shows the location of these drillholes relative to the proposed drilling transect.

3.2 Well Data

The most applicable well data is from Jerboa-1, described below. Other wells in the Great Australian Bight portion of Australia's southern margin are Potoroo-1 (intersecting a similar sequence to Jerboa-1, in the Ceduna Sub-basin to the east); Apollo-1, Gemini-1, and Mercury-1 (in the Polda Trough, in the eastern Great southeastern Great Australian Bight). These other wells provide a general picture of the stratigraphy and depositional history of the Great Australian Bight Basin (Stagg et al., 1990), but do not contribute data additional to that derived from

Jerboa-1 for the Eyre Terrace and adjacent western Great Australian Bight continental shelf area. In addition, wells and boreholes across the Nullarbor Plain provide limited data on the thickness of Tertiary and Late Cretaceous units (Fig. 21).

3.2.1 Jerboa-1

Jerboa-1 was drilled by Esso/Hematite in 1980, as a wildcat oil exploration well in 761 m water depth, above a prominent tilted basement fault block (Fig. 22) located in the southern half-graben of the Eyre Sub-basin (Bein and Taylor, 1981). Flat-lying reflector segments within the Mesozoic section visible on the Esso (1979) seismic data were the primary target, with inferred sand bodies a short distance above basement as secondary targets (Bein and Taylor, 1981). These flat-lying reflectors are not present in the most recent seismic data, indicating that they were an artefact of the water-bottom multiple. Jerboa-1 penetrated 1738 m of Cenozoic and Cretaceous sedimentary section before bottoming in Precambrian metabasalt basement (Fig. 23), and did not encounter any significant hydrocarbon shows. The top 232 m were washed down and cased, so that only 145 m of Tertiary section was actually drilled and logged. No cores were cut in this interval, so lithological and biostratigraphic inferences are based on cuttings and downhole logs. Thermal modelling and vitrinite data (Stagg et al., 1990) indicate that the entire sedimentary section at Jerboa-1 is thermally immature (R_v<0.65%).

3.3 Gravity and Magnetic Data

We have obtained the processed gravity and magnetic data collected as part of the JNOC regional seismic survey, and will forward plots of this data as part of our site survey package.

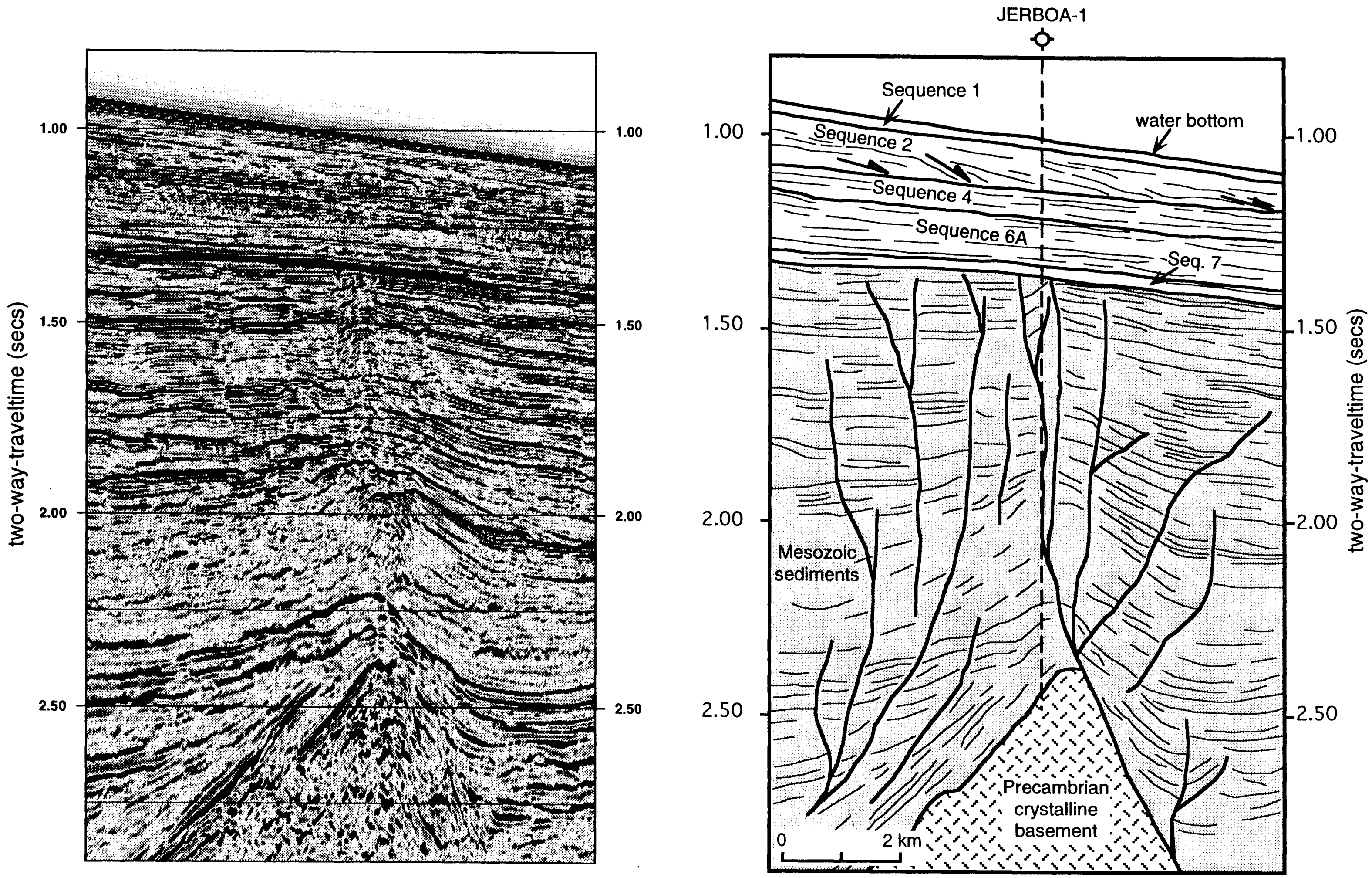


Figure 22. Part of seismic line JA90-23, together with line drawing interpretation, showing the thin Cenozoic sequences and thick Mesozoic section (shaded) intersected by exploration well Jerboa-1.

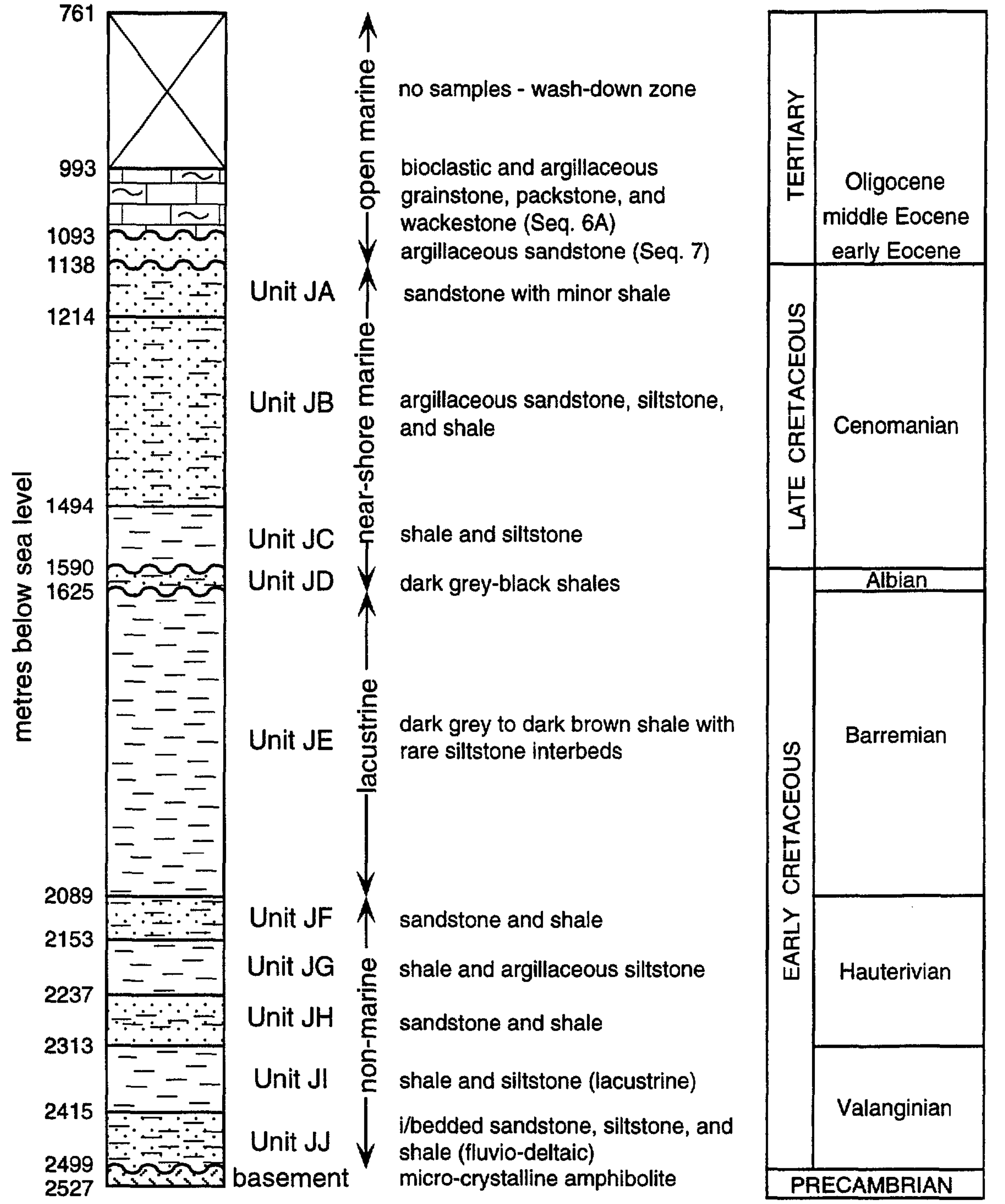


Figure 23. Stratigraphy and paleoenvironmental interpretation of the sequence intersected in Jerboa-1, based on Huebner (1980) and Bein and Taylor (1981), as revised by Stagg et al. (1990).

4. TECHNICAL AND SAFETY CONSIDERATIONS

4.1 Safety Issues

We are aware of the safety risks and technical difficulties attendant upon drilling in very shallow water depths, and are familiar with the SWGHS guidelines. However, we suggest that the extremely shallow basement, consisting of sheared Precambrian granodiorite or granitic gneiss, which underlies sites GAB-10 to GAB-12 at depths of only 500 m to 800 m, significantly reduces the risk of shallow water drilling in this area. We would suggest that a preview by PPSP and ODP-TAMU Safety Panel, prior to final design of site surveys, would be of substantial benefit.

4.2 Drilling Technology Required

A major element of this proposal is the requirement for high core recovery within variably-cemented carbonate horizons. At present, it is our understanding that core recoveries from RCB drilling in cemented carbonates (e.g., Legs 133, 144) have been inadequate to fully answer the types of questions posed in this proposal. Accordingly, we view the refinement and full implementation of the MDCB as extremely important to maximise the potential of many of the proposed Great Australian Bight sites. At many of the shallower sites, we predict that much of the section will consist of relatively easily penetrated (?XCB or even APC) grainstones and wackestones, but with interbedded thin, moderately or highly cemented calcareous and siliceous layers requiring MDCB capability. We understand that the MDCB has had variable success recently (Leg 158), with results that appear particularly promising for the anticipated lithologies in the Great Australian Bight sites. Consequently, we suggest that further testing and refinement of the MDCB would be of immense benefit .

4.3 Site Surveys

Contingent upon this proposal receiving a sufficiently high ranking from ODP scientific panels, the Australian Geological Survey Organisation has tentatively scheduled a site survey cruise into the Great Australian Bight area for late 1995 for site safety purposes, and to refine site locations and identify alternative sites. Prior to this cruise, we will submit our proposed cruise plan to the JOIDES PPSP and SSP, the ODP-TAMU Safety Panel, and the Science Operator (ODP-TAMU). We would welcome comments from these bodies in order to more efficiently design the site survey cruise plan. At present, the intention is to collect a grid of high resolution (using SSI-GI guns) multichannel seismic data over each site, together with magnetometer, gravity, and 3.5 and 12 kHz data. Bottom photographs and cores (gravity, piston, or vibrocores) will also be collected at each site, and side scan sonar surveys will be collected at all sites less than 200 m water depth.

4.4 Drilling Timetable

The following is a tentative drilling timetable for the proposed sites. Site survey data will undoubtedly permit refinement of these estimates, principally as a result of more precise time-depth calculations. Drilling estimates for alternative sites will also be possible after site survey data is analysed.

SITE	MIN. TIME (days)	MAX. TIME (days)	WD (m)	PENETR. (m)	SEISMIC LINE /CDP	DRILL TYPE
GAB-1	5.5	6.5	3875	690	23/19000	APC(3)/XCB/RCB
GAB-2	7.5	8.5	1042	1260	35/14915	APC(3)/XCB/RCB
GAB-3	3	4	681	345	12/21512	APC(2)/XCB
GAB-4	5.5	7	748	650	27/3000 12/27481	APC(2)/XCB
GAB-5	5	6	343	860	27/4164	APC(2)/XCB/RCB
GAB-6	5	6	144	960	27/5116	APC(2)/XCB/RCB
GAB-7	2.5	3	461	575	31/4096	APC(2)/XCB
GAB-8	2.5	3	321	615	31/4376	APC(2)/XCB
GAB-9	2.5	3	191	590	31/4703	APC(2)/XCB
GAB-10	3.5	4	54	440	23/4885	APC(2)/MDCB/XCB
GAB-11	4	5	51	445	23/4408	MDCB/XCB/?RCB
GAB-12	4	5	42	540	19/12724	MDCB/XCB/?RCB
TOTAL	50.5	61				

5. REFERENCES

Almond, D.O., McGowran, B., and Li, Q., 1993. Late Quaternary foraminiferal record from the Great Australian Bight and its environmental significance. Association Australian Paleontologists, Memoir 15, p. 417-428.

Bein, J, and Taylor, M.L., 1981. The Eyre Sub-basin: recent exploration results. APEA Journal, v. 21, p. 91-98.

Benbow, M.C., and Lindsay, J.M., 1988. Discovery of Lepidocyclina (Foraminiferida) in the Eucla basin. Quarterly Notes Geological Survey of South Australia, v. 107, p. 2-8.

Bone, Y., and James, N.P., 1993. Bryozoans as carbonate sediment producers on the cool-water Lacepede Shelf, southern Australia. Sedimentary Geology, v. 85, p. 247-271.

Boreen, T.D., and James, N.P., 1993. Holocene sediment dynamics on a cool-water carbonate shelf, southeastern Australia. Journal Sedimentary Petrology, v. 63, p. 574-588.

Boreen, T.D., James, N.P., Wilson, C., and Heggie, D., 1993. Surficial sediments of the Otway margin: A cool water carbonate shelf. Marine Geology, v. 112, p. 35-56.

Buddemeier, R.W., and Oberdorfer, 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, p. 91-111.

Choquette, P.W., and Pray, L.C., 1970. Geologic nomenclature and classification of porosity in sedimentary carbonates. American Association of Petroleum Geologists Bulletin, v. 54, p. 207-250.

Cita, M.B., and McKenzie, J.A., 1986. The terminal Miocene event. In Hsu, K. J. (ed.), Mesozoic and Cenozoic Oceans, Washington, D. C., American Geophysical Union, p. 123-140.

Collins, L.B., 1988. Sediments and history of the Rottnest Shelf, southwest Australia: a swell-dominated, non-tropical carbonate margin. Sedimentary Geology, v. 60, p. 15-50.

COSOD II, 1987. Report of the second conference on scientific ocean drilling. European Science Foundation, Strasbourg, France, 142 pp.

Davies, H.L., Clarke, J.L.A., Stagg, H.M.J., Shafik, S., McGowran, B., and Willcox, J.B., 1989. Maastrichtian and younger sediments from the Great Australian Bight. Bureau Mineral Resources, Report 288, 40 pp.

Driscoll, N.W., Weissel, J.K., Karner, G.D., and Mountain G.S., 1991. Stratigraphic responses of a carbonate platform to relative sea level changes: Broken Ridge, Southeast Indian Ocean. American Association of Petroleum Geologists Bulletin, v. 75, p. 803-831.

Duncan, R.A., 1981. Hotspots in the southern oceans - An absolute frame of reference for motion of the Gondwana continents. In Solomon, S.C., Van der Voo, R., and Chinnery, M.A., (eds), Quantitative Methods for Assessing Plate Motions. Tectonophysics, v. 74, p. 29-42.

Elderfield, H., Swart, P.K., McKenzie, J.A., and Williams, A., 1993. The strontium isotopic composition of pore waters from Leg 133: Northeast Australian margin. In McKenzie, J.A., and Davies, P.J., (eds), Proceedings of the Ocean Drilling Program, Scientific Results: College Station, Texas, Ocean Drilling Program, p. 473-480.

Etheridge, M.A., Branson, J.C., Falvey, D.A., Lockwood, K.L., Stuart-Smith, P.G., and Scherl, A.S., 1984. Basin-forming structures and their relevance to hydrocarbon exploration in Bass Basin, southeastern Australia. BMR Journal of Australian Geology and Geophysics, v. 9, p. 197-206.

Etheridge, M.A., Symonds, P.A., and Lister, G.S., 1990. Application of the detachment model to reconstruction of conjugate passive margins. In Tankard, A.J., and Balkwill, H.R., (eds), Extensional tectonics and stratigraphy of the North Atlantic margins. American Association of Petroleum Geologists Memoir 46, p. 23-40.

Feary, D.A., and James, N.P., 1994. Cenozoic seismic stratigraphy of the western Great Australian Bight, offshore Eucla Basin. Australian Geological Survey Organisation, Record 1994/, (in press).

Feary, D. A. and James, N. P., submitted. Cenozoic reefs and biogenic mounds on a cool-water carbonate continental margin - Eucla Basin, Great Australian Bight. Geology (submitted).

Feary, D.A. et al., 1993. Geological sampling in the Great Australian Bight, Scientific Post-Cruise Report - R.V. Rig Seismic Cruise 102. Australian Geological Survey Organisation, Record 1993/18, 140 pp.

Frakes, L.A., Probst, J.-L., and Ludwig, W., 1994. Latitudinal distribution of paleotemperature on land and sea from early Cretaceous to middle Miocene. C.R. Acad. Sci. Paris, t. 318, ser. II, p. 1209-1218.

Hanshaw, B.B., and Bach, W., 1980. Chemical mass-wasting on the northern Yucatan Peninsula by groundwater dissolution. Geology, v. 8, p. 222-224.

Haq, B.U., Hardenbol, J., and Vail, P.R., 1987. The chronology of fluctuating sea level since the Triassic. Science, v. 235, p. 1156-1167.

Hegarty, K.A., Weissel, J.K., and Mutter, J.C., 1988. Subsidence history of Australia's southern margin: constraints on basin models. American Association of Petroleum Geologists Bulletin, v. 72, p. 615-633.

Howard, W.R., and Prell, W.L., 1992. Late Quaternary surface circulation of the southern Indian Ocean and its relationship to orbital variations. Paleoceanography, v. 7, p. 79-118.

Huebner, P.U., 1980. Well completion report, Jerboa-1, Eyre Basin, Western Australia. Esso Australia Ltd report (unpubl.).

Idnurm, M., 1985. Late Mesozoic and Cenozoic paleomagnetism of Australia-II. Implications for geomagnetism and true polar wander. Geophysical Journal of the Royal Astronomical Society, v. 83, p. 419-433.

Idnurm, M., 1986. Late Mesozoic and Cenozoic paleomagnetism of Australia-III. Bias-corrected pole paths for Australia, Antarctica and India. Geophysical Journal of the Royal Astronomical Society, v. 86, p. 277-287.

James, N.P., and Bone, Y., 1989. Petrogenesis of Cenozoic, temperate water calcarenites, south Australia: A model for meteoric/shallow burial diagenesis of shallow water calcite sediments. Journal Sedimentary Petrology, v. 59, p. 191-204.

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

James, N.P., and Bone, Y., 1992. Synsedimentary cemented calcarenite layers in Oligo-Miocene shelf limestones, Eucla Platform, southern Australia. Journal Sedimentary Petrology, v. 62, p. 860-872.

James, N.P., Bone, Y., von der Borch, C.C., and Gostin, V.A., 1992. Modern carbonate and terrigenous clastic sediments on a cool-water, high-energy, mid-latitude shelf; Lacepede, southern Australia. Sedimentology, v. 39, p. 877-904.

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

James, N.P., and Bourque, P.-A., 1992. Reefs and Mounds. In Walker, R.G., and James, N.P., (eds), Facies Models, Response to Sea Level Change. Geological Association of Canada, p. 323-348.

James, N.P., and Feary, D.A., 1993. Great Australian Bight: Evolution of a Cenozoic carbonate continental margin. ODP Drilling Program, Proposal 367-Rev., 113 pp.

James, N.P., and Kendall, A.C., 1992. Introduction to carbonate and evaporite facies models. In Walker, R.G., and James, N.P., (eds), Facies Models, Response to Sea Level Change. Geological Association of Canada, p. 265-276.

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

Kendall, C.St.C.G., and Schlager, W., 1981. Carbonates and relative changes in sea level. Marine Geology, v. 44, p. 181-212.

Kennett, J.P., and Barron, J.A., 1992. Introduction. In Kennett, J.P. and Warnke, D.A., (eds), The Antarctic Paleoenvironment: A perspective on Global Change. Antarctic Research Series, American Geophysical Union, v. 56, p. 1-6.

Li, Q., and McGowran, B., 1994. Miocene upwelling events: foraminiferal evidence from southern Australia. Australian Journal Earth Science, v. 41, (in press).

Lindsay, J.M., and Harris, W.K., 1975. Fossiliferous marine and non-marine Cenozoic rocks from the eastern Eucla Basin, South Australia. Mineral Resources Review South Australia, v. 138, p. 29-42.

Lowry, D.C., 1970, Geology of the Western Australian part of the Eucla Basin. Geological Survey of Western Australia Bulletin, v. 122, 201 pp.

McGowran, B., 1986. Cenozoic oceanic and climatic events: The Indo-Pacific foraminiferal biostratigraphic record. Paleogeography Paleoclimatology Paleoecology, v. 55, p. 247-265.
McGowran, B., 1989. The later Eocene transgressions in southern Australia. Alcheringa, v. 13, p. 45-68.
McGowran, B., and Beecroft, A., 1986. Neritic, southern extratropical foraminifera and the Terminal Eocene Event. Paleogeography Paleoclimatology Paleoecology, v. 55, p. 23-34.
McGowran, B., and Li, Q., 1994. The Miocene oscillation in southern Australia. Records South Australian Museum, v. 27, p. 197-212.
McKenzie, J.A., Isern, A.R., 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., and Palmer-Julson, A., et al., Proceedings of the Ocean Drilling Program, Scientific Results, Leg 133: College Station, Texas (Ocean Drilling Program), p. 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, p. 8-26.
Melim, L.A., Swart, P.K, and Maliva, R.G., 1994. Diagenesis of carbonates from the Bahamas Drilling Project, western margin Great Bahama Bank: Meteoric versus marine burial diagenesis. SEPM Special Publication, (in press).
Miller, K.G., Fairbanks, R.G., and Mountain, G. S., 1987. Tertiary oxygen isotope synthesis, sea level history and continental margin erosion. Paleoceanography, v. 2, p. 1-19.
Mullins, H.T., Heath, K.C., Van Buren, M., and Newton, K., 1984. Anatomy of a modern open-ocean carbonate slope: Northern Little Bahama Bank. Sedimentology, v. 31, p. 141-168.
Nelson, C.S., 1988. An introductory perspective on non-tropical shelf carbonates. Sedimentary Geology, v. 60, p. 3-14.
Prothero, D. R., and Berggren, W.A. (eds), 1994. Eocene-Oligocene Climatic and Biologic Evolution, Princeton University Press, Princeton, N. J.
Reeckmann, S.A., 1979. Detailed stratigraphy of the Tertiary sequence, Torquay, Victoria - facies, environment and diagenesis. Ph.D. Dissertation, University of Melbourne, Victoria, Australia, 318 pp.
Sarg, J.F., 1988. Carbonate sequence stratigraphy, In Wilgus, C.K., et al., (eds), Sea level change; an integrated approach, SEPM Special Publication, v. 42, p. 155-181.
Schlager, W., 1992. Stratigraphic response of a carbonate platform to relative sea level changes: Broken Ridge, southeast Indian Ocean: Discussion. American Association of Petroleum Geologists Bulletin, v. 76, p. 1034-1036.
Seibold, E., and Berger, W.H., 1993. The sea floor: an introduction to marine geology, 2nd edition. Springer Verlag.
Simms, M., 1984. Dolomitization by groundwater flow systems in carbonate platforms. Transactions Gulf Coast Association Geological Society, v. 34, p. 411-420.

Stagg, H.M.J., Cockshell, C.D., Willcox, J.B., Hill, A.J., Needham, D.J.L., Thomas, B., O'Brien, G.W., and Hough, L.P., 1990. Basins of the Great Australian Bight region: Geology and petroleum potential. Bureau of Mineral Resources, Continental Margins Program, Folio 5.

Stagg, H.M.J, and Willcox, J.B., 1993. Investigation of a lower-plate continental margin: an interim proposal for drilling in the Great Australian Bight region through the Ocean Drilling Program. ODP Drilling Program, Letter of Intent 31, 31 pp.

Tedford, R.H., 1994. Succession of Pliocene through medial Pleistocene mammal faunas of southern Australia. Records South Australian Museum, v. 27, p. 79-93.

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

Vahrencamp, V.C., Swart, P.K., and Ruiz, J., 1991. Episodic dolomitization of late Cenozoic dolomites in the Bahamas: Evidence from strontium isotopes. Journal Sedimentary Petrology, v. 61, p. 1002-1015.

Veevers, J.J, Stagg, H.M.J., Willcox, J.B., and Davies, H.L., 1990. Pattern of slow seafloor spreading (<4mm/year) from breakup (96Ma) to A20 (44.5Ma) off the southern margin of Australia. Bureau of Mineral Resources Journal of Australian Geology and Geophysics, v. 11, p. 499-507.

Veevers, J.J., 1990. Antarctic-Australia fit resolved by satellite mapping of oceanic fracture zones. Australian Journal of Earth Sciences, v. 37, p. 123-126.

Wellman, P., 1983. Hotspot volcanism in Australia and New Zealand: Cainozoic and mid-Mesozoic. Tectonophysics, v. 96, p. 225-243.

Willcox, J.B., Symonds, P.A., and Stagg, H.M.J., 1987. Tectonic evolution of the central Southern Margin of Australia. Australian Bureau of Mineral Resources, Record 1987/51, p. 150-160.

Willcox, J.B., Stagg, H.M.J., Davies, H.L., et al., 1988. Rig Seismic Research Cruises 10 & 11: Geology of the central Great Australian Bight region. Bureau of Mineral Resources, Report 286, 140 pp.

Wilson, J. L., 1975. Carbonate facies in geologic history, Springer-Verlag, Heidelberg, 471 pp.

Wright, J.D., Miller, K.G., and Fairbanks, R.G., 1992. Early and middle Miocene stable isotopes: implications for deep-water circulation and climate. Paleoceanography, v. 7, p. 357-390.

Zachos, J.C., Stott, L.D., and Lohmann, K.C., 1994. Evolution of early Cenozoic marine temperatures. Paleoceanography, v. 9, p. 353-387.

6. PROPOSED DRILL SITES IN THE GREAT AUSTRALIAN BIGHT

The following descriptions of the proposed drill sites in the western Great Australian Bight (Fig. 24) 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. 25.

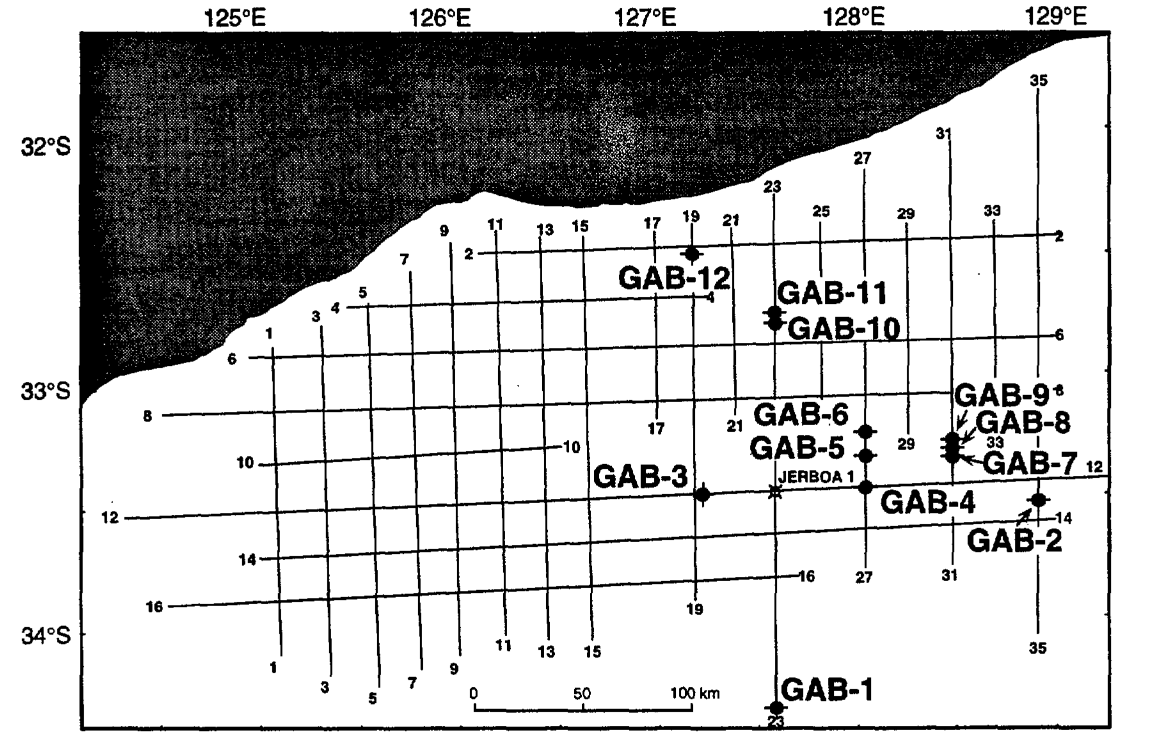


Figure 24. Map showing distribution of the proposed transect of ODP sites in the western Great Australian Bight, together with JNOC (1990) seismic tracks.

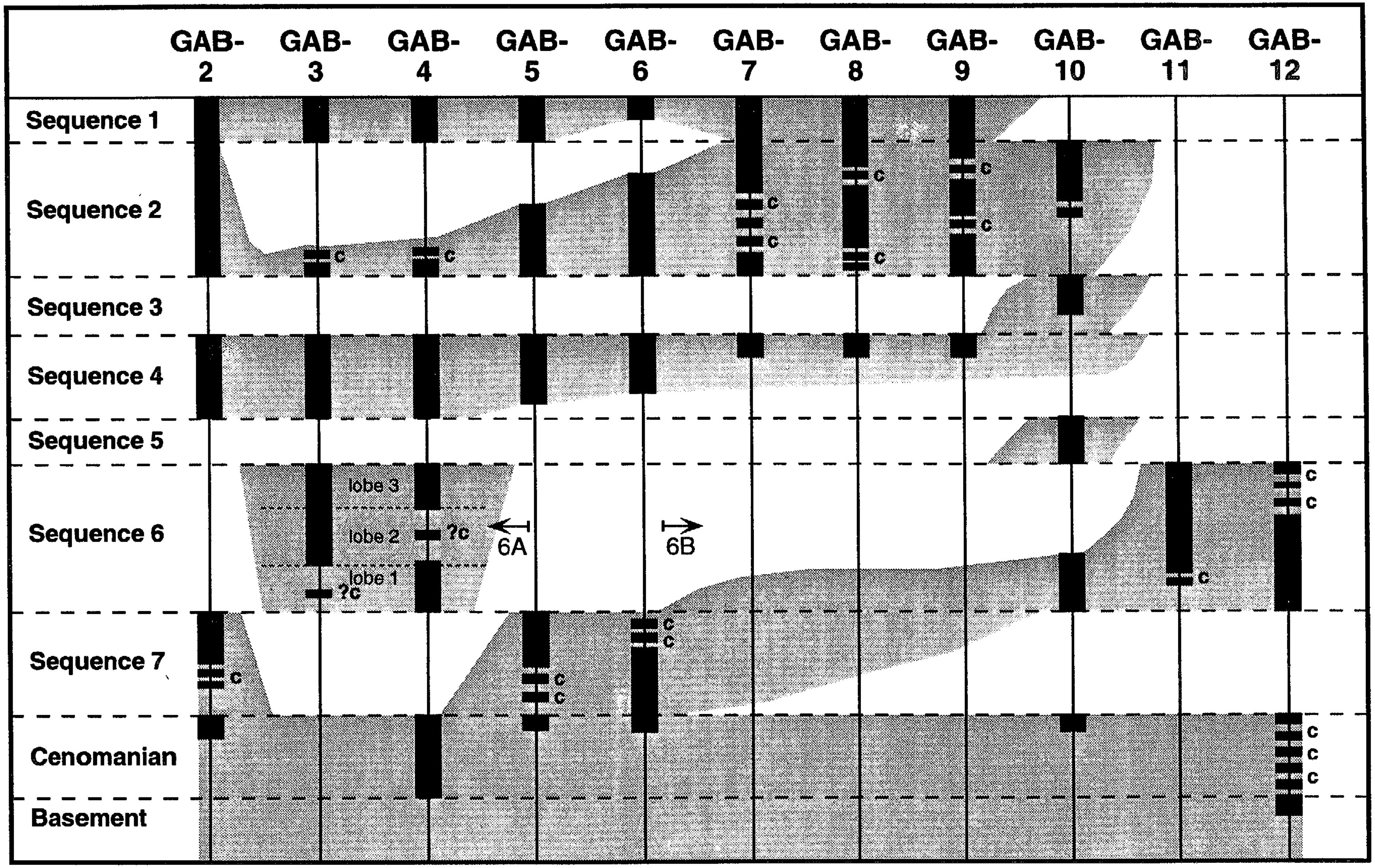


Figure 25. Chart showing sampling strategy for proposed sites GAB-2 to GAB-12. Cenozoic sequences are not differentiated at site GAB-1. **c** = condensed and/or discontinuous portion of sequence.

6.1 Sites GAB-1 and GAB-2

Sites GAB-1 (southern Australian continental rise) and GAB-2 (mid-upper slope) are paleoceanographic sites located to intersect sections that collectively span the entire Cenozoic succession. These sites comprise the deep-water component of the shelf-to-basin transect.

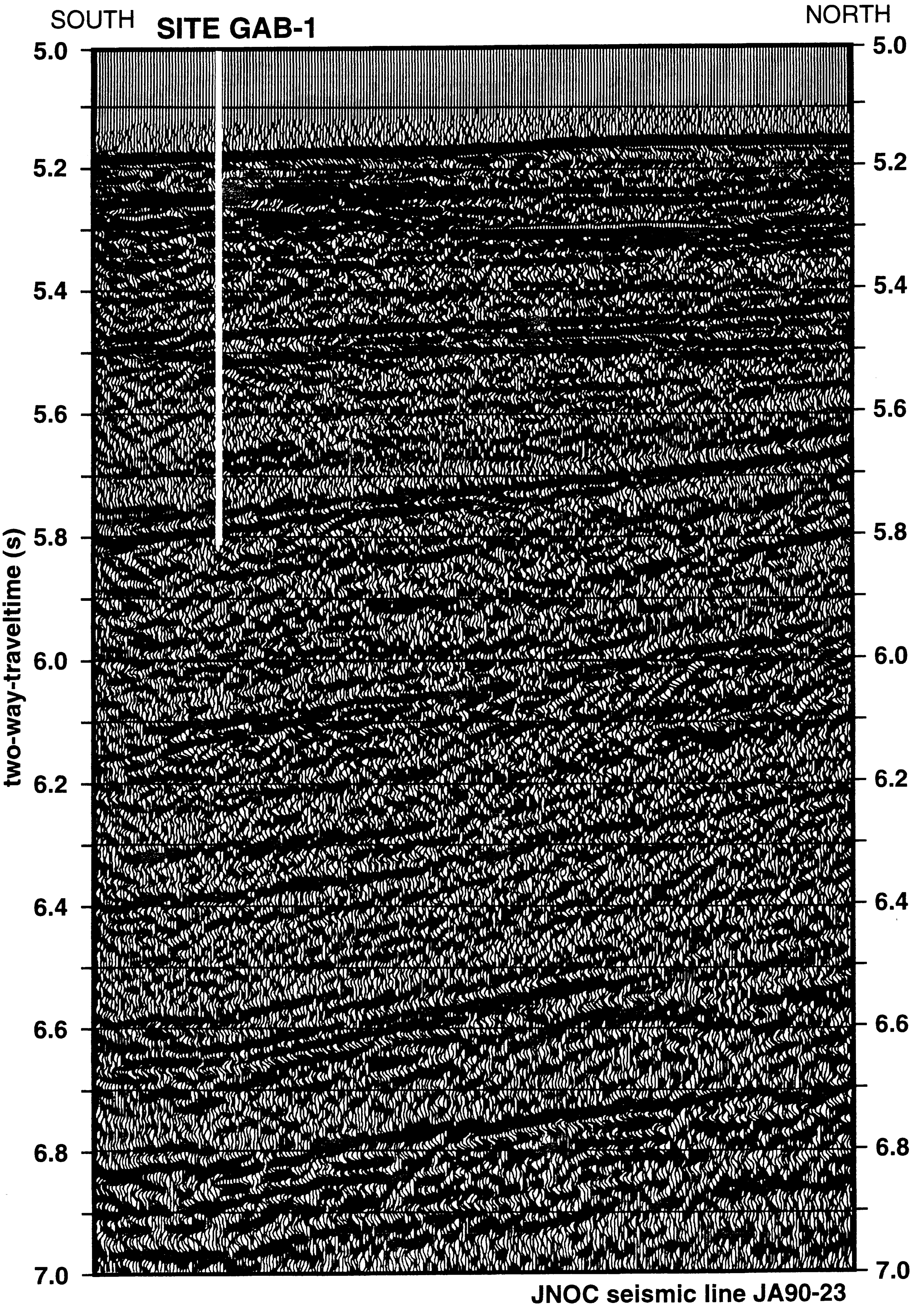
Principal Objective:

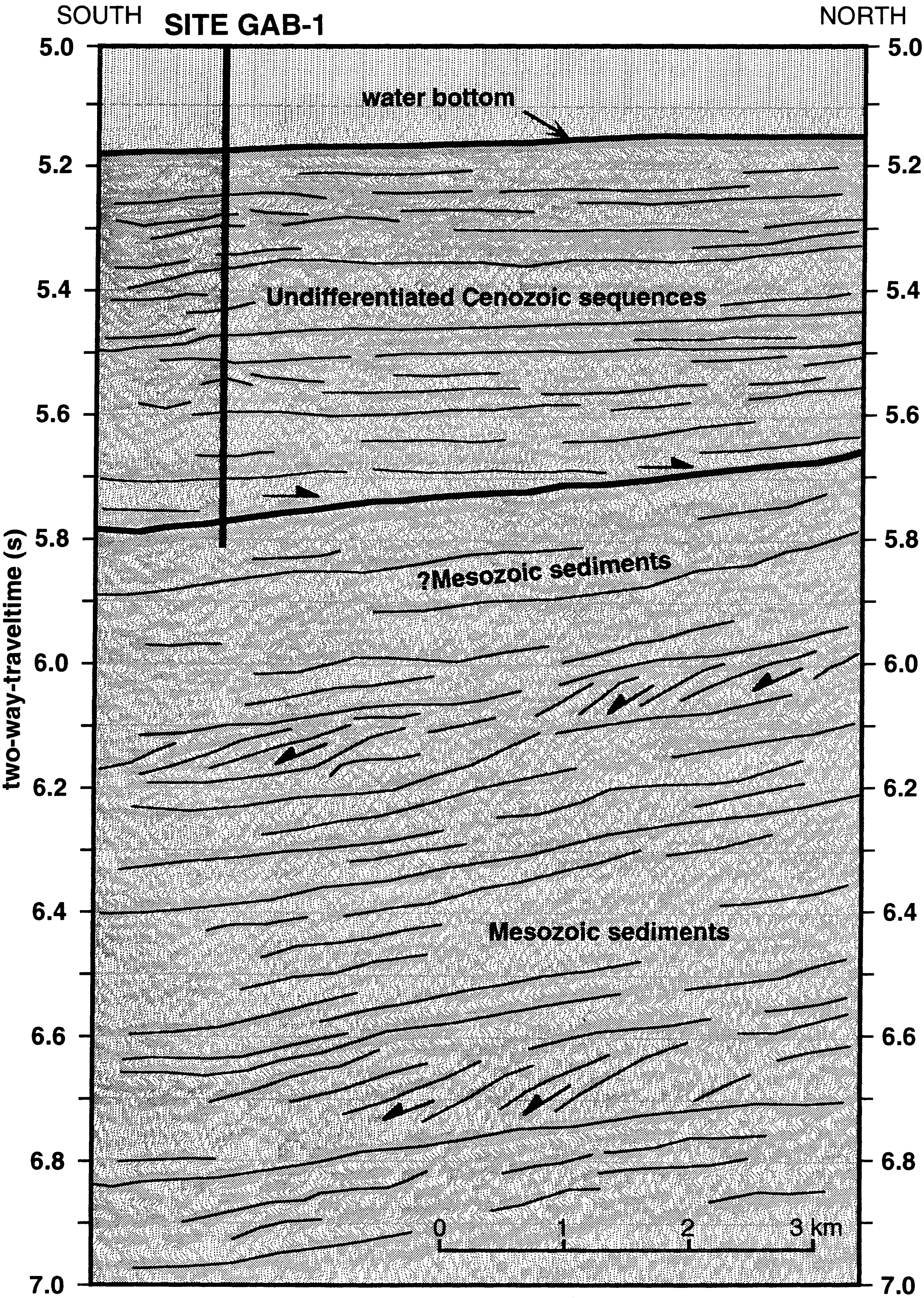
- ► to obtain a complete record of the Cenozoic section in a deep oceanic setting, with the principal aim of elucidating the evolution of the circum-Antarctic Current within the evolving seaway between Australia and Antarctica. As the condensed section in Jerboa-1 contains early Oligocene faunas, there 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:

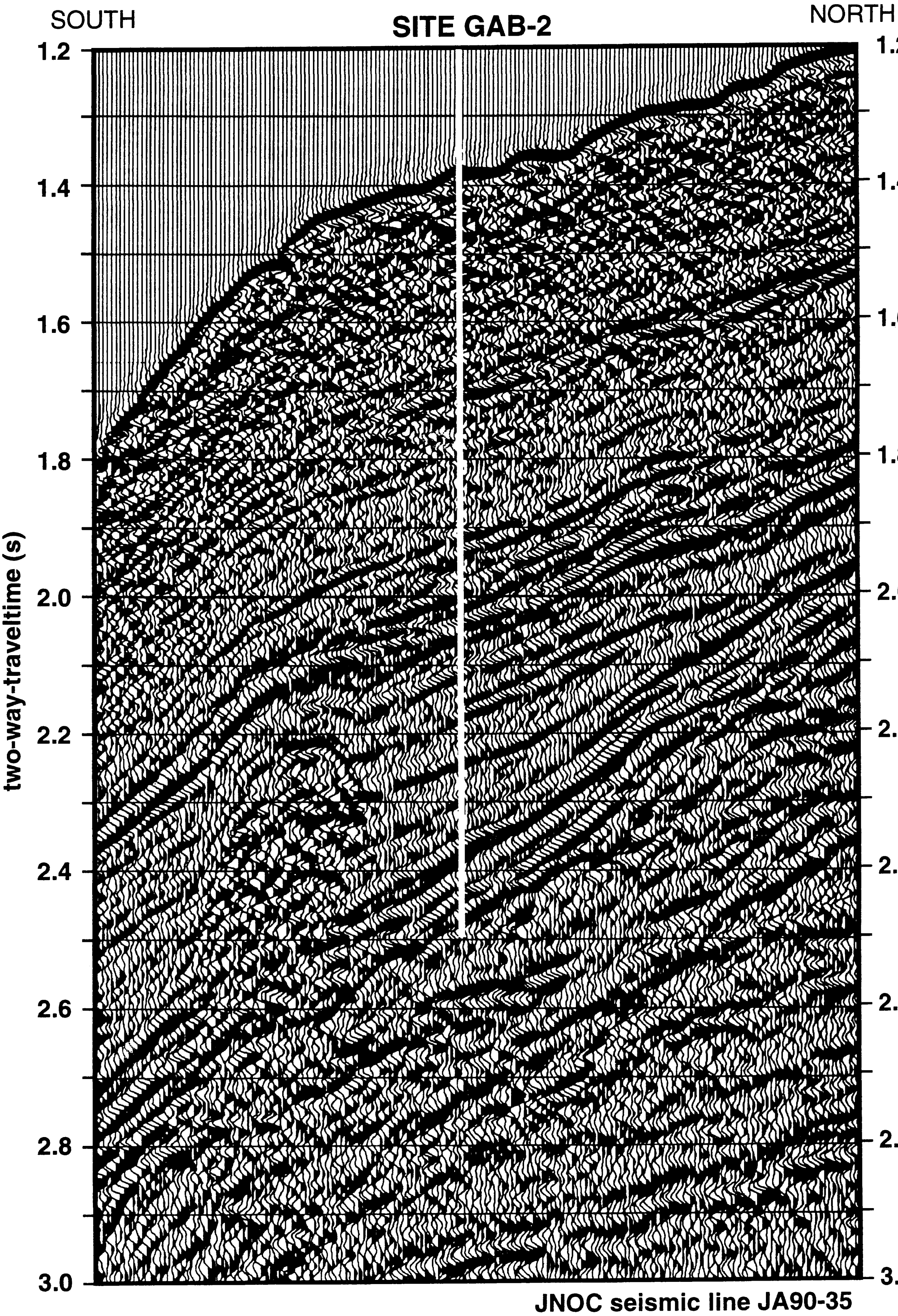
- ► to determine depositional and diagenetic facies in mid-upper slope and continental rise settings.

Note: because this is essentially a starved margin, there are unlikely to be major sediment gravity flow components at either site.

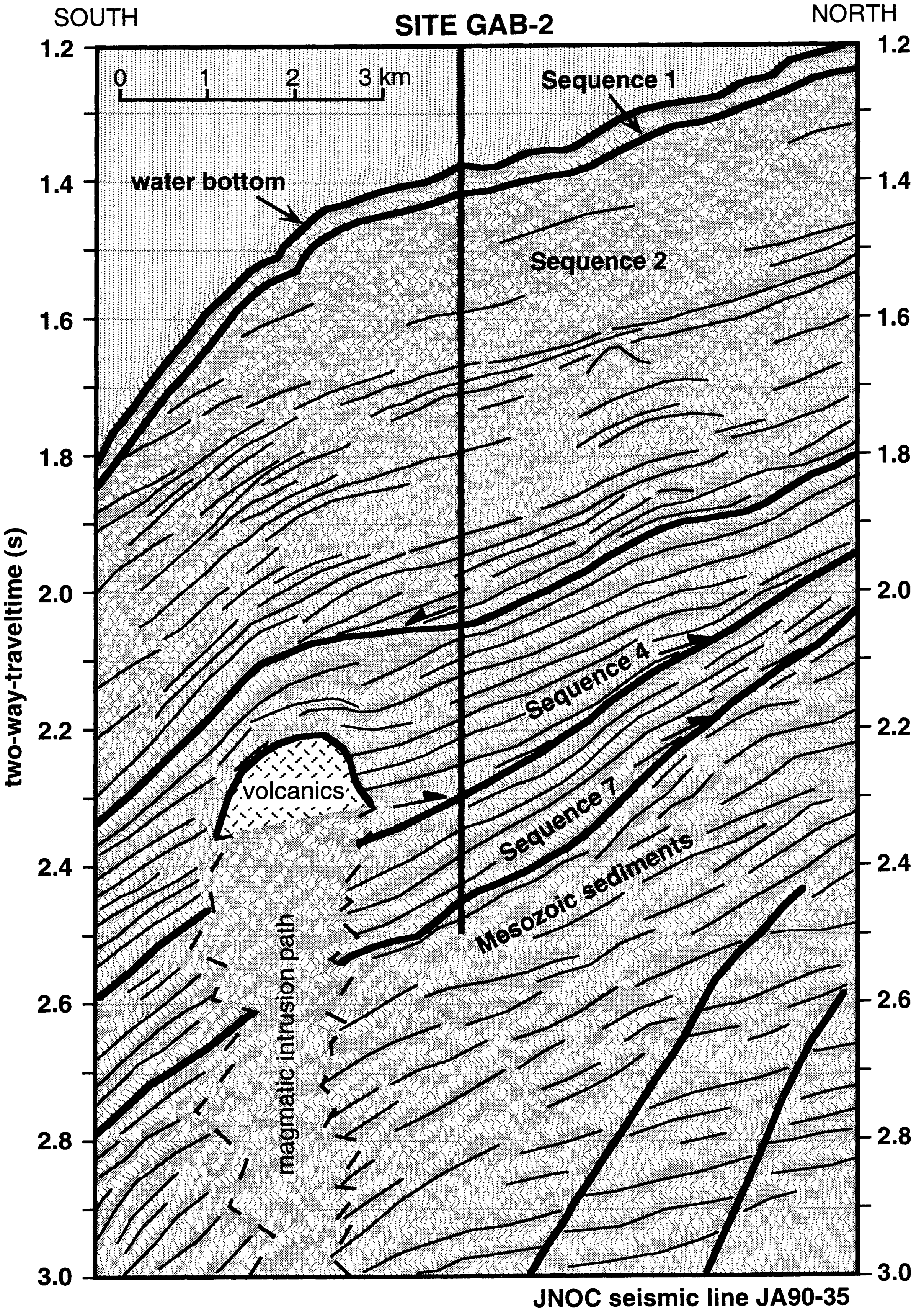

SOUTH
SITE GAB-1
NORTH
two-way-traveltime (s)
5.0
5.2
5.4
5.6
5.8
6.0
6.2
6.4
6.6
6.8
7.0
JNOC seismic line JA90-23



JNOC seismic line JA90-23



SOUTH
SITE GAB-2
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-2
NORTH
0 1 2 3 km
Sequence 1
water bottom
Sequence 2
Sequence 4
volcanics
Sequence 7
Mesozoic sediments
magmatic intrusion path
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 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 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-1)	
Area:	upper continental rise, Great Australian Bight	
Lat./Long.:	34° 23' 44.5"S 127° 35' 26.5"E	
Water Depth:	3875 m	
Sed. Thickness:	3325 msec TWT; ≈4125 m	
Total penetration:	625 msec TWT; ≈690 m	

	Sediments	Basement
Penetration:	625 msec TWT; ≈690 m	Nil
Lithology(ies):	690 m variably cemented wackestone and grainstone	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

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 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-2)	
Area:	middle-upper slope, Great Australian Bight	
Lat./Long.:	33° 32' 33.1"S 128° 54' 17.5"E	
Water Depth:	1042 m	
Sed. Thickness:	2705 msec TWT; ≈3325 m	
Total penetration:	1125 msec TWT; ≈1260 m	

	Sediments	Basement
Penetration:	1125 msec TWT; ≈1260 m	Nil
Lithology(ies):	1065 m variably cemented wackestone and grainstone; 195 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 14915 (SP 7498)

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

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6.2 Sites GAB-3 and GAB-4

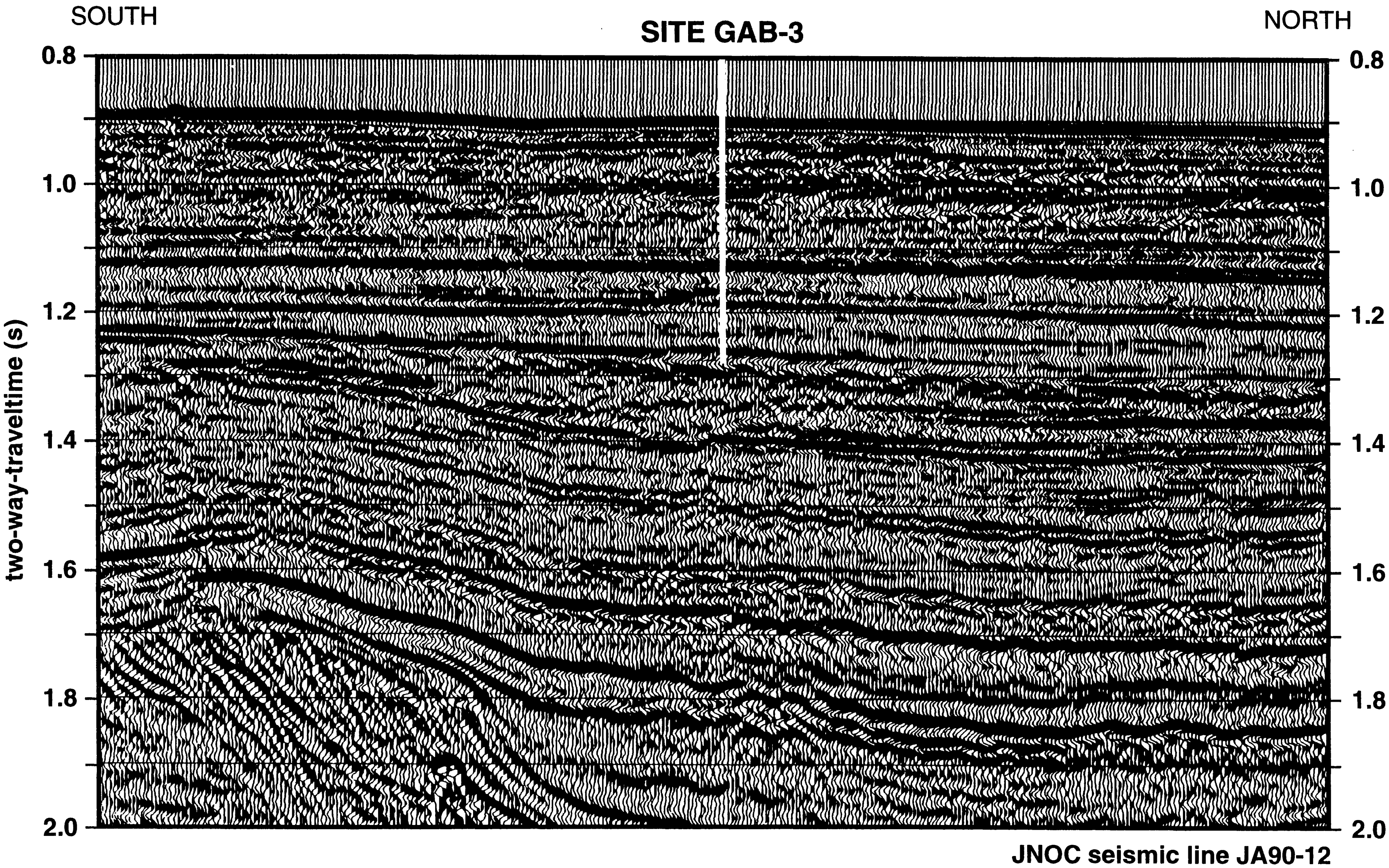
Sites GAB-3 and GAB-4 are located to intersect the Eocene to early Middle Miocene section deposited in lobes on the upper slope, coeval with deposition of the extensive carbonate platform on the continental shelf. In addition, these sites will also intersect an early Neogene succession poorly sampled at other sites; a highly condensed late Neogene succession; and the upper part of the marine Cenomanian section at Site GAB-4.

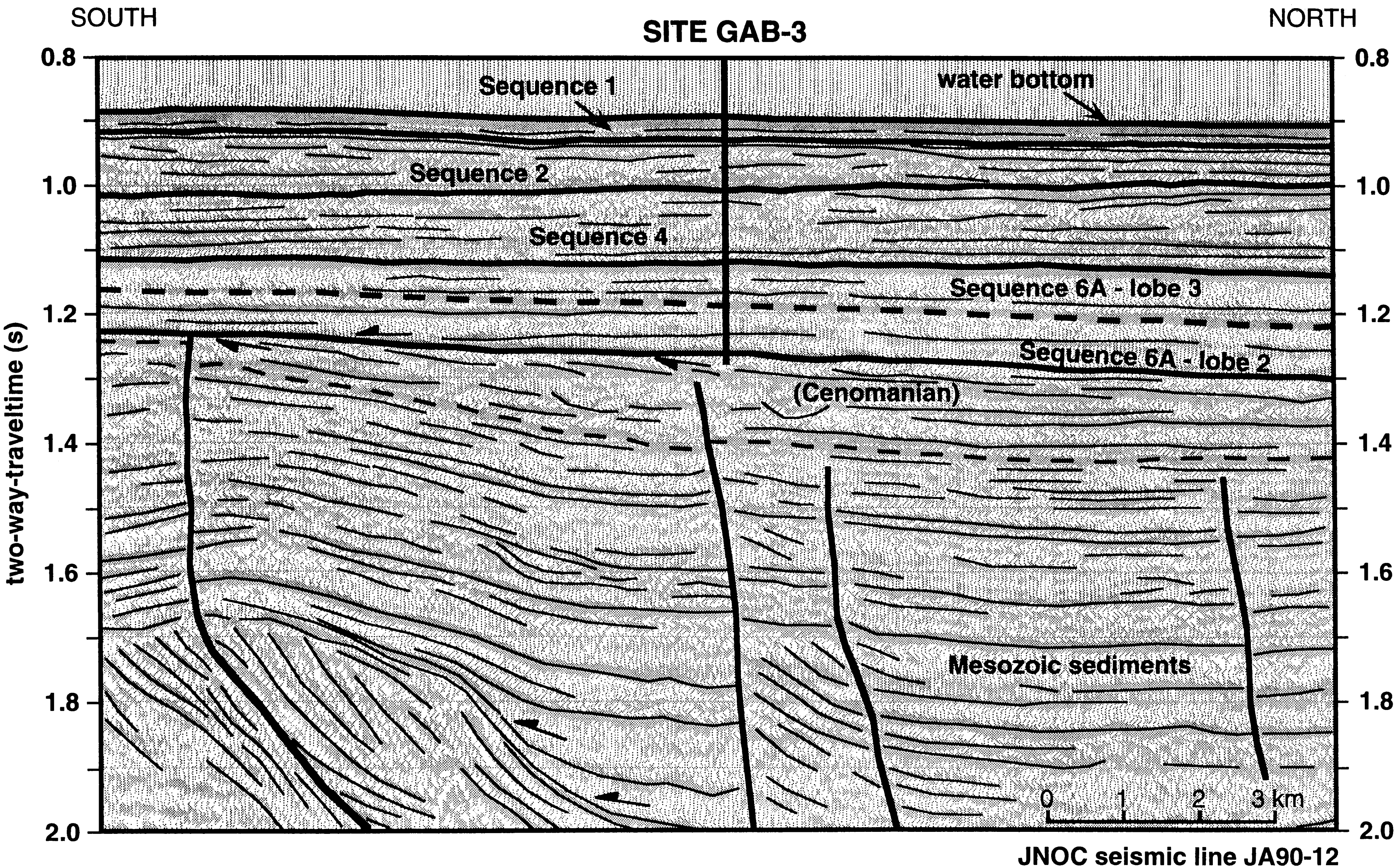
Principal Objectives:

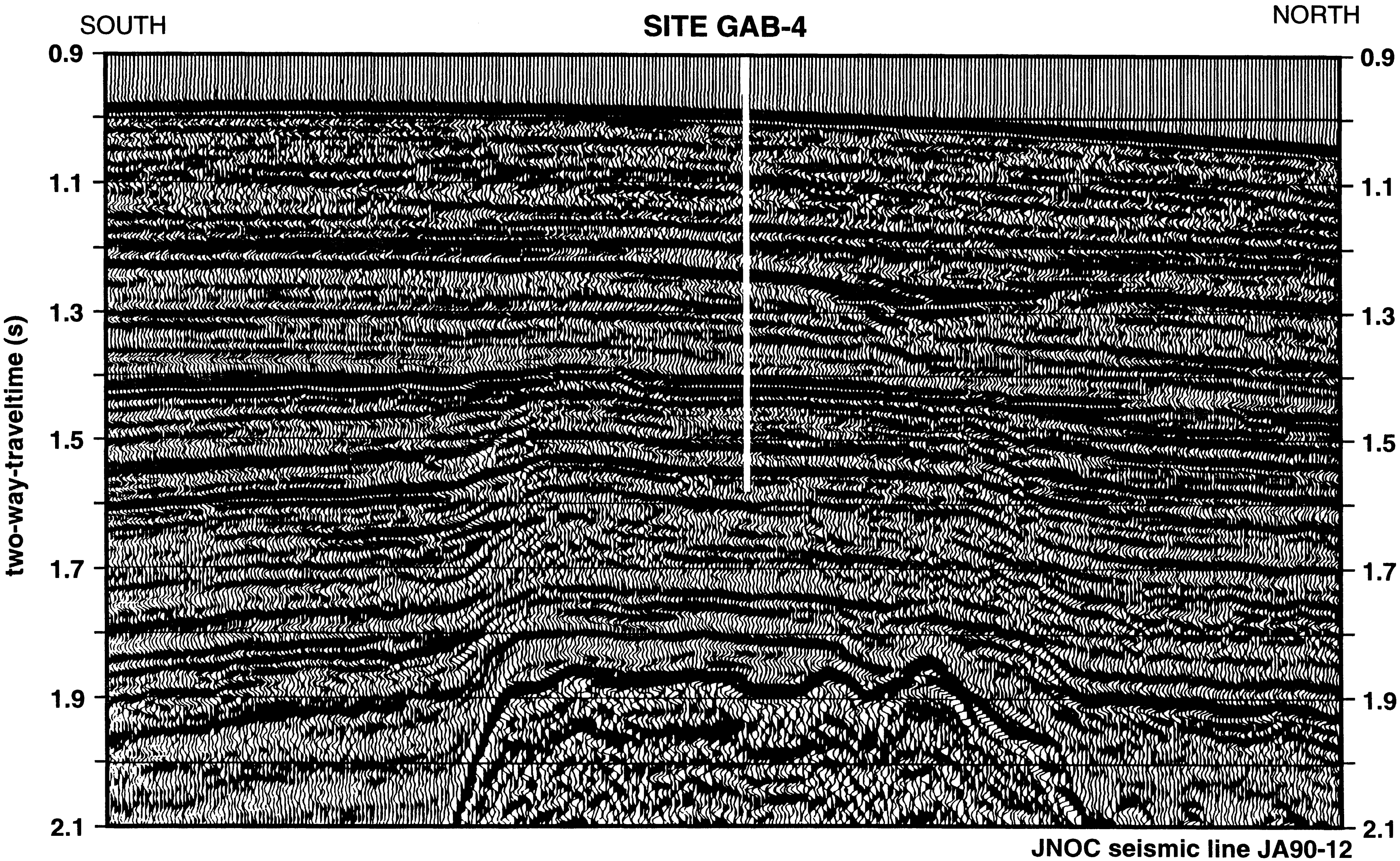
- ► to collect a detailed record of Paleogene-early Neogene temperate to subtropical, mid-latitude sedimentation in an upper slope environment. Low sea level hiatuses within the carbonate platform sequence further inshore at Sites GAB-11 and GAB-12 should be represented by thin sequences on the upper slope. For portions of the succession occurring at both locations, direct comparison of shelf and off-shelf depositional facies will be possible.
- ► to determine depositional facies and paleoceanographic parameters representing initial marine flooding of the evolving rift basin in the Cenomanian (Site GAB-4).

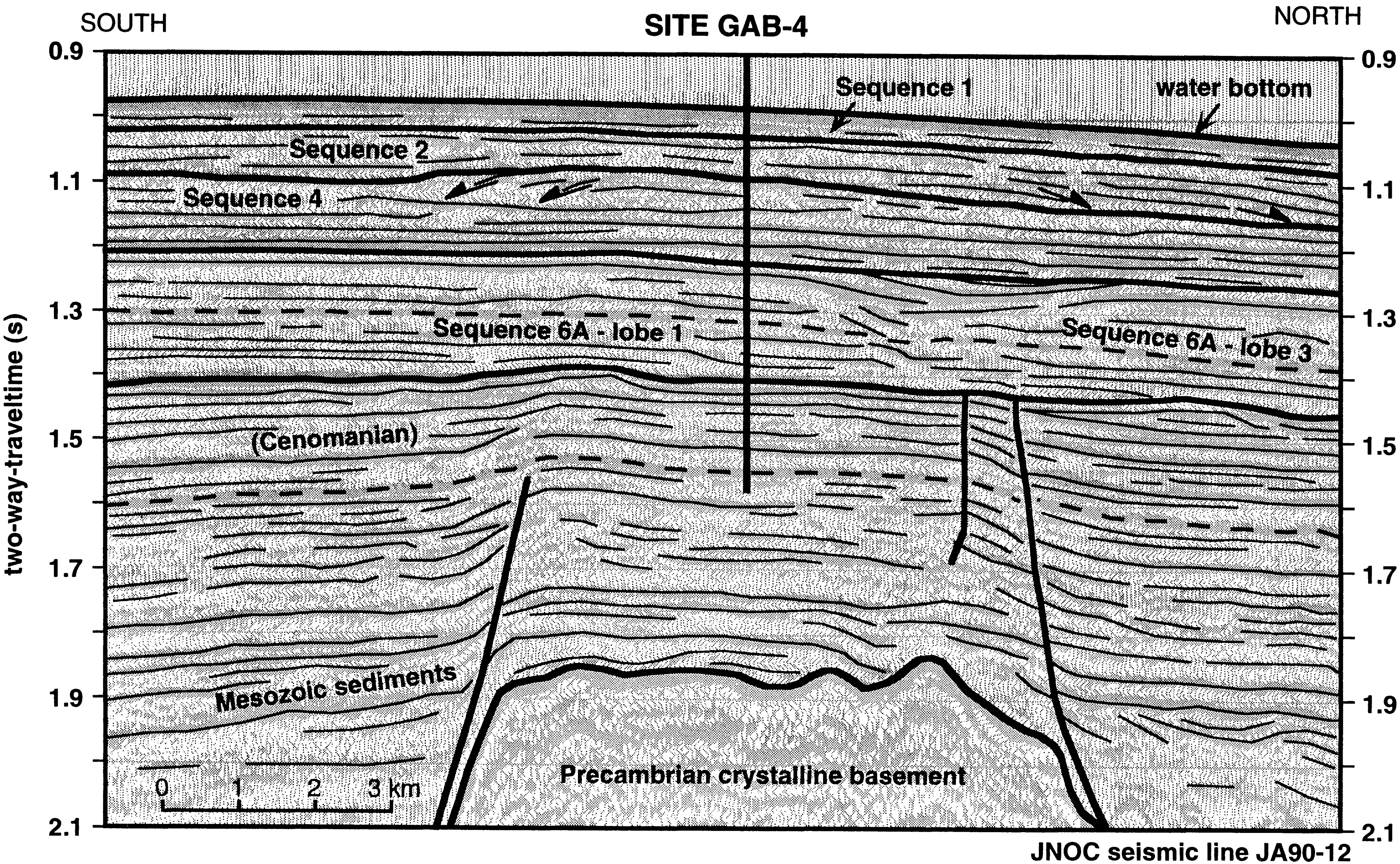
Additional Objectives:

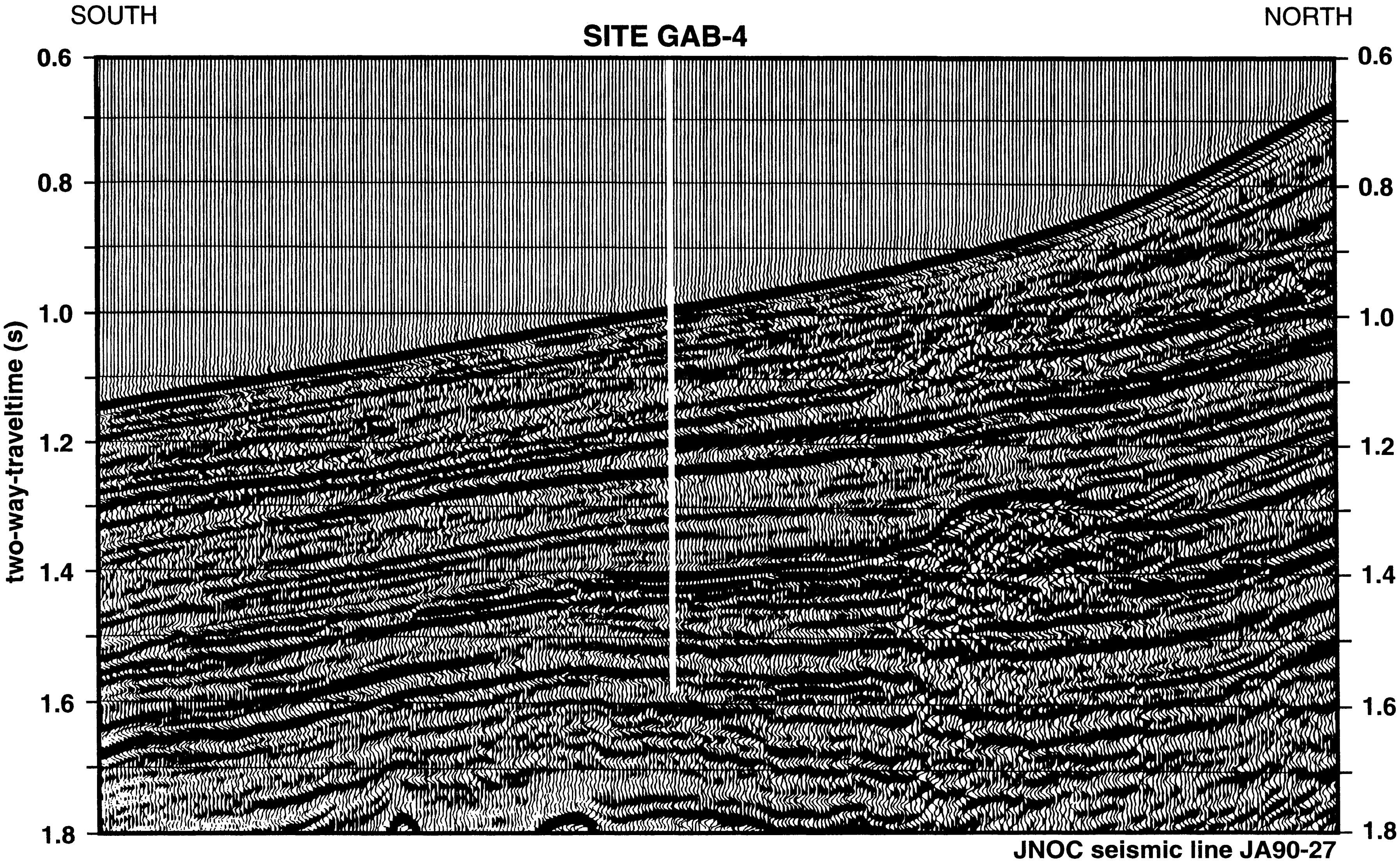
- ► to determine the characteristics of upper slope, cool-water carbonate facies within the Neogene succession (Sequences 2 and 4).
- ► to determine paleoceanographic parameters within an upper slope setting in Sequences 2 and 4, to complement other components of the shelf-to-basin transect.
- ► to evaluate sealevel control on Neogene facies within an upper slope setting.
- ► to evaluate the diagenetic history and processes within Neogene facies in an upper slope setting.

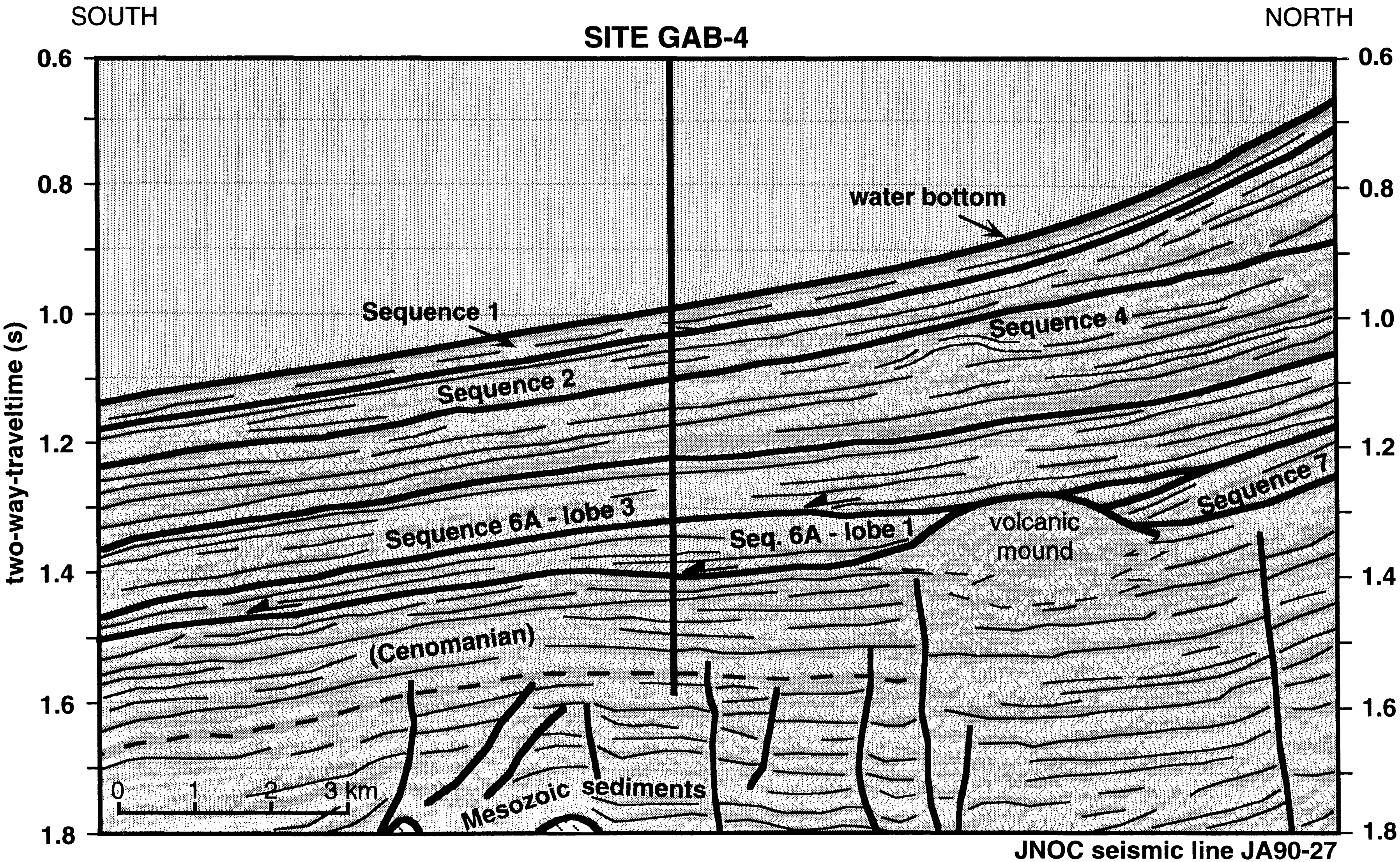

SOUTH
SITE GAB-3
NORTH
two-way-traveltime (s)
0.8
1.0
1.2
1.4
1.6
1.8
2.0
JNOC seismic line JA90-12


SOUTH
SITE GAB-3
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


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

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-3)	
Area:	Eyre Terrace, Great Australian Bight	
Lat./Long.:	33° 30' 42.9"S 127° 14' 51.8"E	
Water Depth:	681 m	
Sed. Thickness:	1978 msec TWT; ≈2375 m	
Total penetration:	380 msec TWT; ≈345 m	

	Sediments	Basement
Penetration:	380 msec TWT; ≈345 m	Nil
Lithology(ies):	340 m variably-cemented wackestone with minor grainstone; 5 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 21512 (SP 10797)

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

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-4)	
Area:	Eyre Terrace, Great Australian Bight	
Lat./Long.:	33° 29' 33.6"S 128° 02' 59.6"E	
Water Depth:	748 m	
Sed. Thickness:	890 msec TWT; ≈1025 m	
Total penetration:	580 msec TWT; ≈650 m	

	Sediments	Basement
Penetration:	580 msec TWT; ≈650 m	Nil
Lithology(ies):	515 m variably-cemented wackestone with minor grainstone; 135 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

R9406205

6.3 Sites GAB-5 and GAB-6

Sites GAB-5 and GAB-6 are located to intersect distal (GAB-5) and proximal (GAB-6) 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)

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.

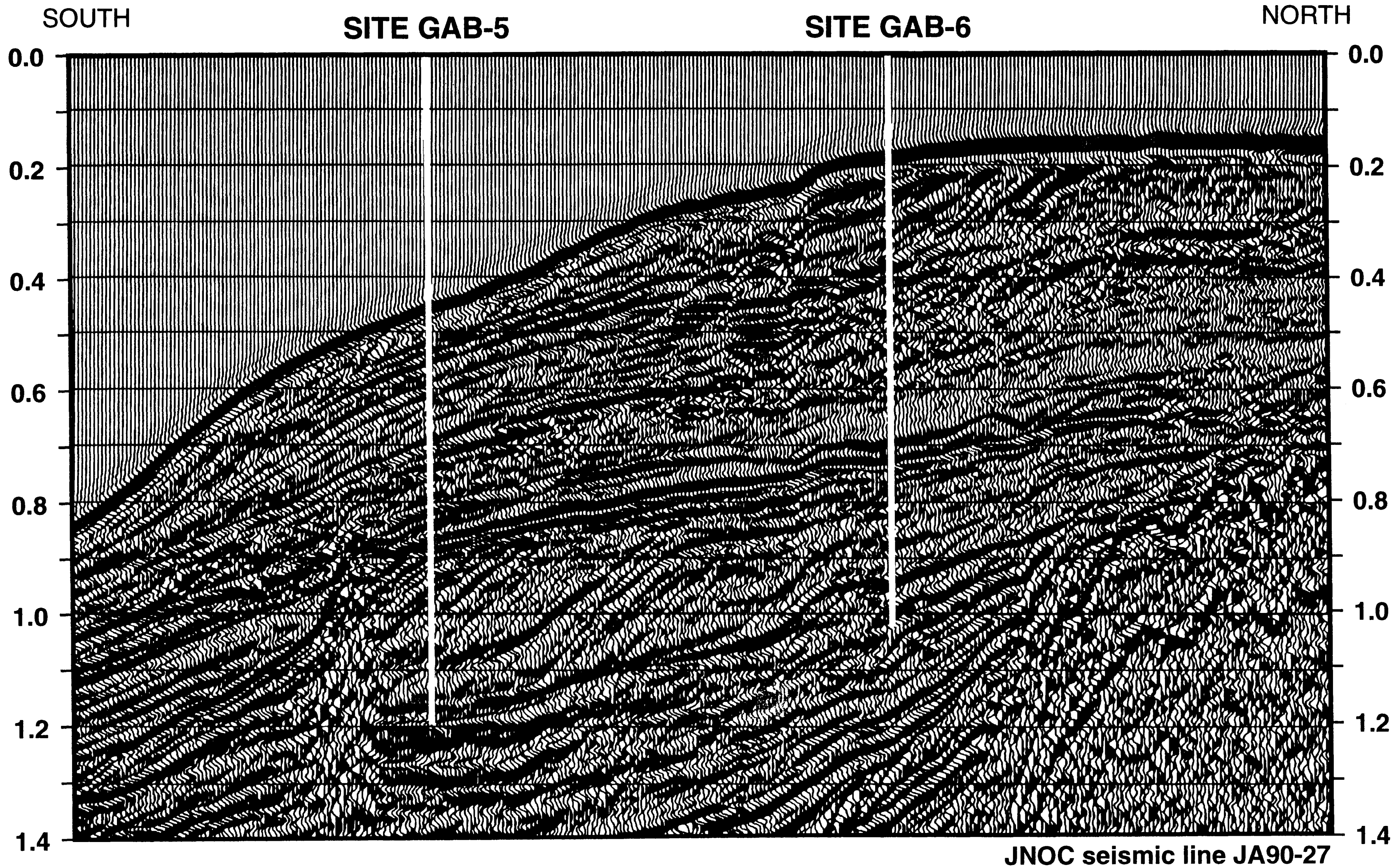
Additional Objectives:

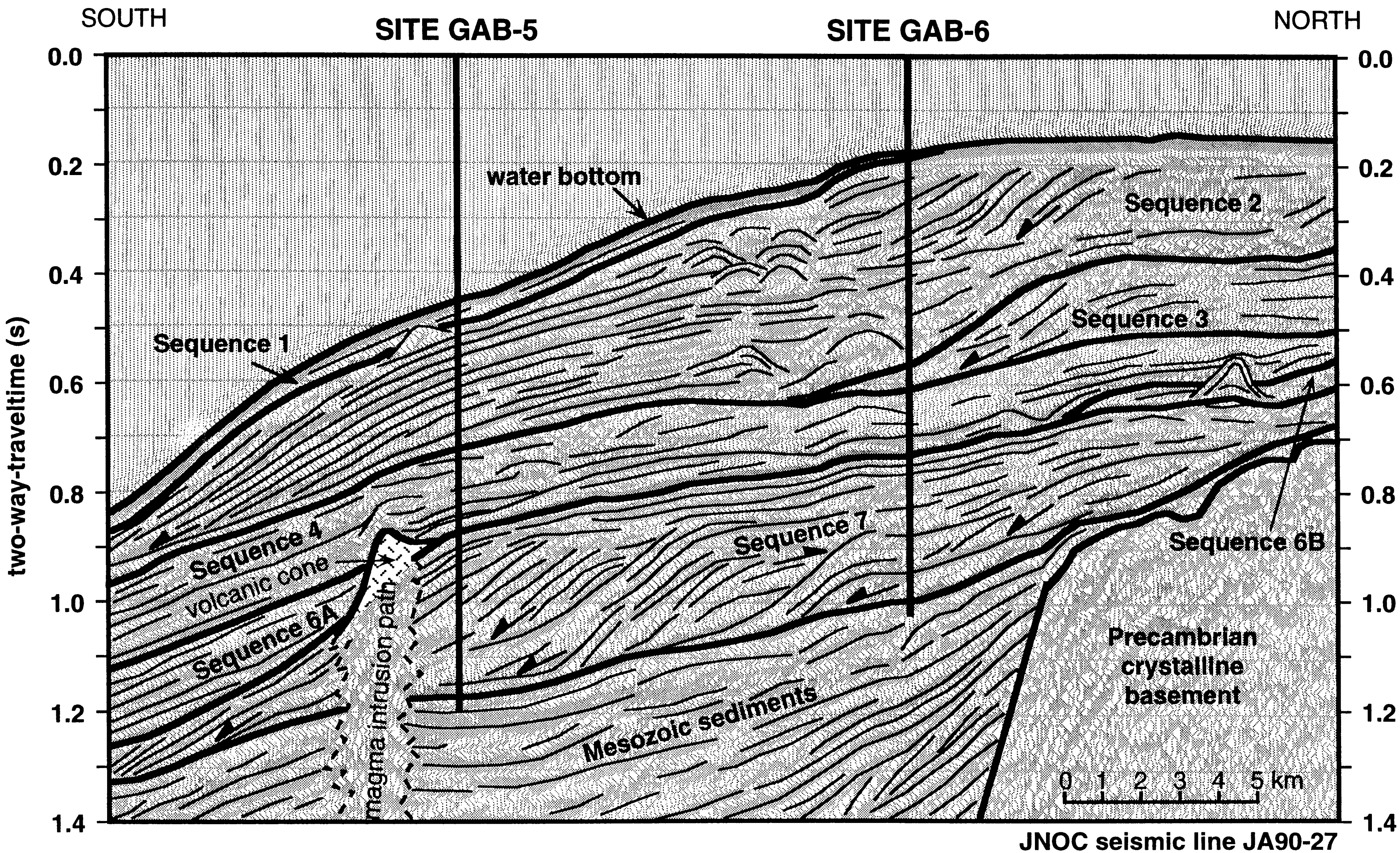
► to determine the characteristics of cool-water carbonate facies within the Neogene succession (Sequences 2 to 4).

► 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 sealevel control on Neogene facies within an upper slope / shelf-edge setting.

► to evaluate the diagenetic history and processes within Neogene facies in an upper slope / shelf-edge setting.


SOUTH
SITE GAB-5
SITE GAB-6
NORTH
two-way-traveltime (s)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
JNOC seismic line JA90-27


SOUTH
SITE GAB-5
SITE GAB-6
NORTH
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
two-way-traveltime (s)
water bottom
Sequence 1
Sequence 2
Sequence 3
Sequence 4
volcanic cone
Sequence 6A
Sequence 6B
Sequence 7
magma intrusion path
Mesozoic sediments
Precambrian crystalline basement
0 1 2 3 4 5 km
JNOC seismic line JA90-27

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 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-5)	
Area:	upper slope-Eucla Shelf, Great Australian Bight	
Lat./Long.:	33° 21' 42.3"S 128° 03' 02.1"E	
Water Depth:	343 m	
Sed. Thickness:	2905 msec TWT; ≈3590 m	
Total penetration:	755 msec TWT; ≈860 m	

	Sediments	Basement
Penetration:	755 msec TWT; ≈860 m	Nil
Lithology(ies):	460 m variably cemented grainstone and wackestone; 400 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 JA90-27; cdp 4164 (SP 2122)

	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

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-6)	
Area:	shelf edge - Eucla Shelf, Great Australian Bight	
Lat./Long.:	33° 15' 15.5"S 128° 03' 04.0"E	
Water Depth:	144 m	
Sed. Thickness:	3130 msec TWT; ≈3865 m	
Total penetration:	855 msec TWT; ≈960 m	

	Sediments	Basement
Penetration:	855 msec TWT; ≈960 m	Nil
Lithology(ies):	590 m variably cemented grainstone and wackestone; 370 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 JA90-27; cdp 5116 (SP 2599)

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

6.4 Sites GAB-7 to GAB-9

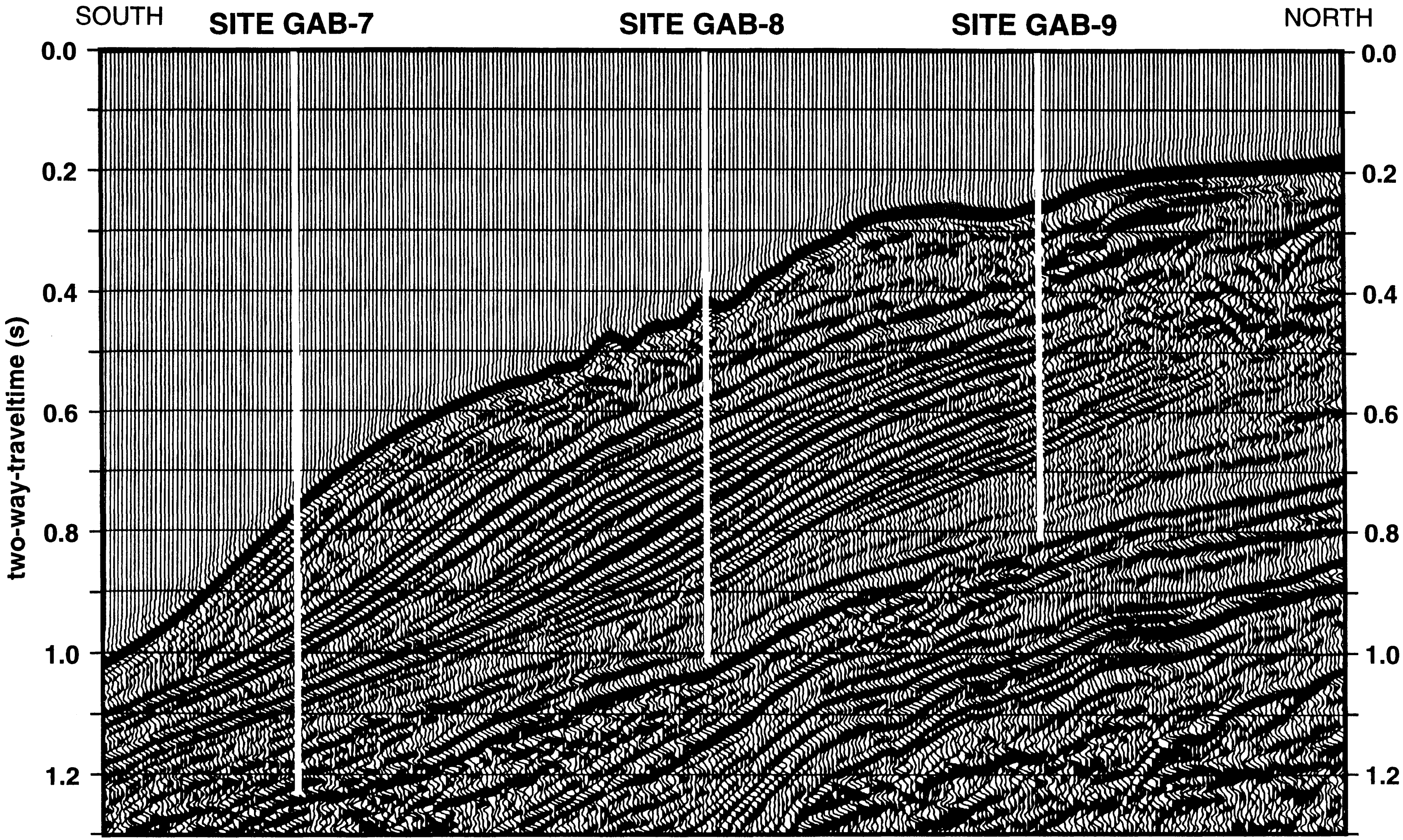
Sites GAB-7 to 9 will intersect a spectacular set of late Neogene (?Plio-Pleistocene) clinoforms underlying the present-day shelf edge. Site GAB-7 will intersect the lowest, more condensed portion of the clinoform sequence, but will also have the best record of the youngest clinoforms; Site GAB-8 will 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-9 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.

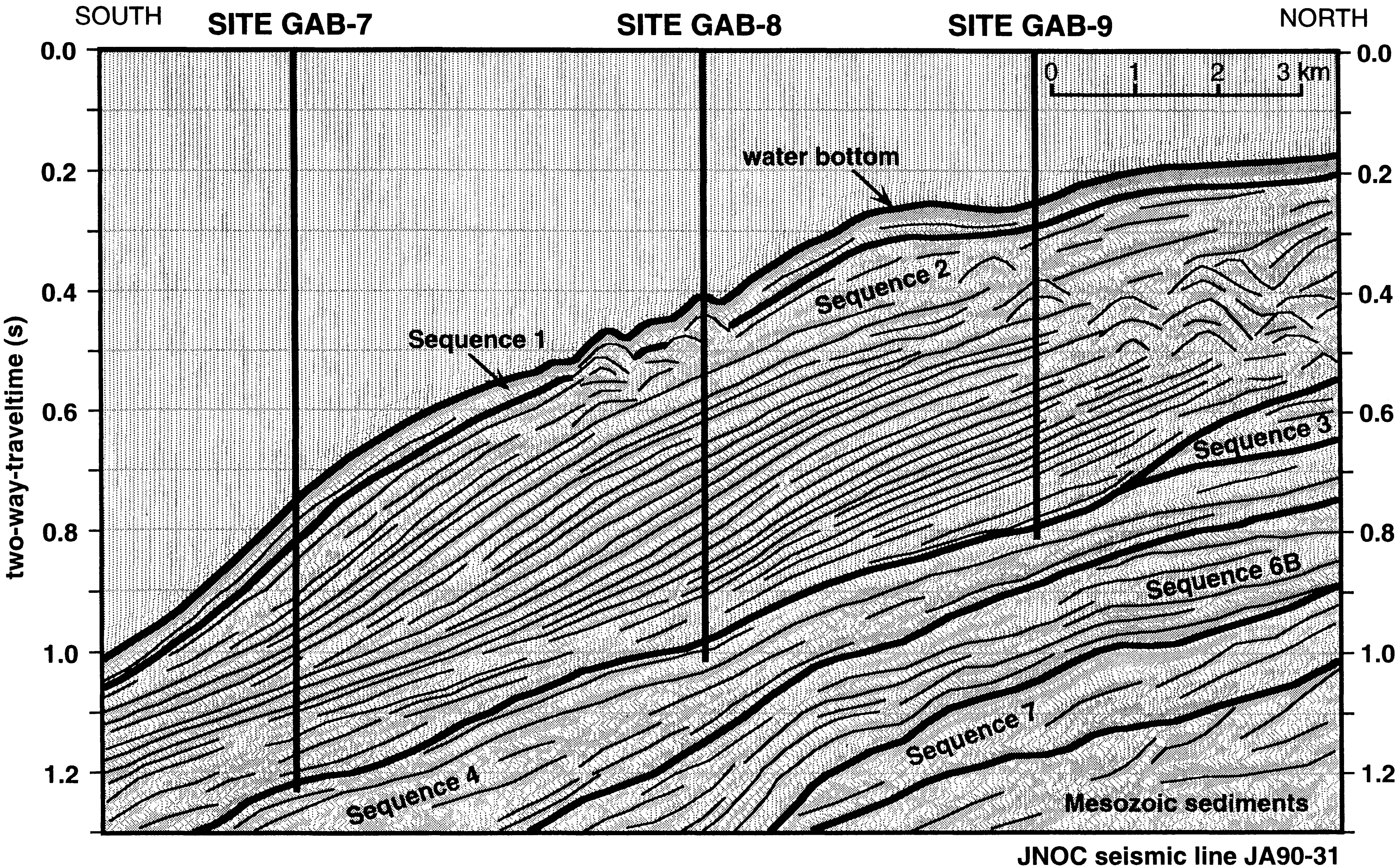
Additional Objectives:
▶ to obtain a high resolution record of late Neogene paleoceanographic variation within an upper slope to shelf-edge setting, as a component of the shelf-to-basin paleoceanographic transect.

▶ 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-9 is presently in 191 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.



JNOC seismic line JA90-31


SOUTH
SITE GAB-7
SITE GAB-8
SITE GAB-9
NORTH
0 1 2 3 km
two-way-traveltime (s)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
water bottom
Sequence 1
Sequence 2
Sequence 3
Sequence 6B
Sequence 7
Sequence 4
Mesozoic sediments
JNOC seismic line JA90-31

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-7)	
Area:	upper slope-Eucla Shelf, Great Australian Bight	
Lat./Long.:	33° 21' 27.7"S 128° 28' 53.1"E	
Water Depth:	461 m	
Sed. Thickness:	1825 msec TWT; ≈2190 m	
Total penetration:	575 msec TWT; ≈575 m	

	Sediments	Basement
Penetration:	575 msec TWT; ≈575 m	Nil
Lithology(ies):	575 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

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-8)	
Area:	upper slope-Eucla Shelf, Great Australian Bight	
Lat./Long.:	33° 19' 34.1"S 128° 28' 52.9"E	
Water Depth:	321 m	
Sed. Thickness:	1995 msec TWT; ≈2400 m	
Total penetration:	615 msec TWT; ≈615 m	

	Sediments	Basement
Penetration:	615 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 4376 (SP 2229)

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

R9406209

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-9)	
Area:	shelf-edge - Eucla Shelf, Great Australian Bight	
Lat./Long.:	33° 17' 21.7"S 128° 28' 52.0"E	
Water Depth:	191 m	
Sed. Thickness:	1850 msec TWT; ≈2220 m	
Total penetration:	590 msec TWT; ≈590 m	

	Sediments	Basement
Penetration:	590 msec TWT; ≈590 m	Nil
Lithology(ies):	590 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		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 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 2392)

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

6.5 Sites GAB-10 and GAB-11

Site GAB-10 is intended to intersect the ?Late Miocene (Sequence 5) and Pliocene (Sequences 2 and 3) succession onlapping against the carbonate platform escarpment. Site GAB-11 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.

Principal Objectives:

► to evaluate the paleotemperature control on deposition of the "Little Barrier Reef" rimmed carbonate platform margin, by contrasting paleotemperatures derived from both sites.

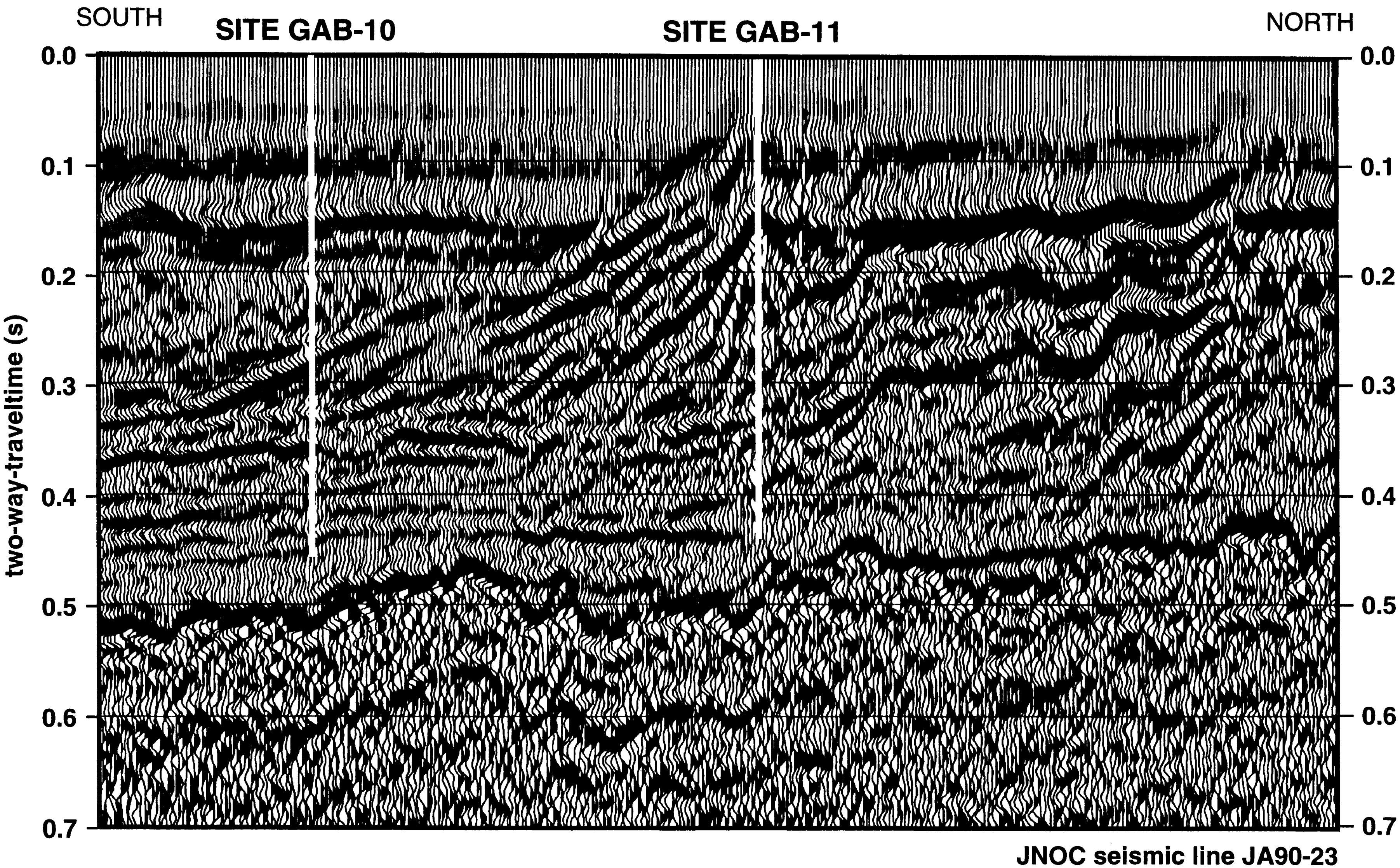
► to describe the carbonate facies deposited in both rimmed carbonate platform and cool-water inner shelf environments.

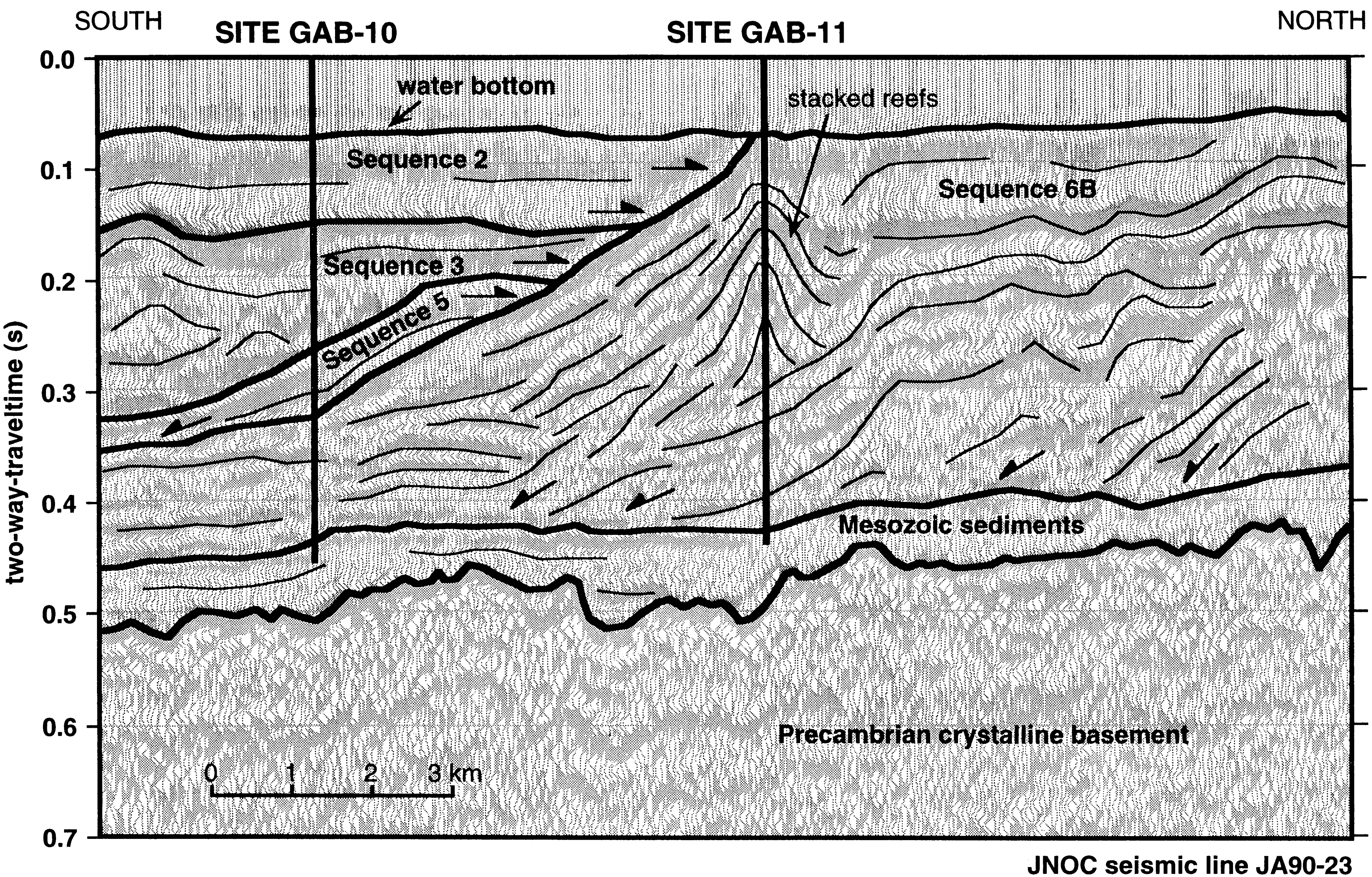
► to describe the faunal composition and community structure of the reefs which form the carbonate platform margin.

► 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-10.


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


SOUTH
SITE GAB-10
SITE GAB-11
NORTH
water bottom
stacked reefs
Sequence 2
Sequence 6B
Sequence 3
Sequence 5
Mesozoic sediments
Precambrian crystalline basement
0 1 2 3 km
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

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-10)	
Area:	inner Eucla Shelf, Great Australian Bight	
Lat./Long.:	32° 48' 43.6"S 127° 36' 26.7"E	
Water Depth:	54 m	
Sed. Thickness:	480 mS TWT; ≈530 m	
Total penetration:	400 mS TWT; ≈440 m	

	Sediments	Basement
Penetration:	400 mS TWT; ≈440 m	
Lithology(ies):	430 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		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		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 4885 (SP 2483)

	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

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 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-11)	
Area:	middle Eucla Shelf, Great Australian Bight	
Lat./Long.:	32° 45' 31.3"S 127° 36' 28.5"E	
Water Depth:	51 m	
Sed. Thickness:	455 msec TWT; ≈500 m	
Total penetration:	405 msec TWT; ≈445 m	

	Sediments	Basement
Penetration:	405 mS TWT; ≈445 m	Nil
Lithology(ies):	435 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):

No.		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		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)

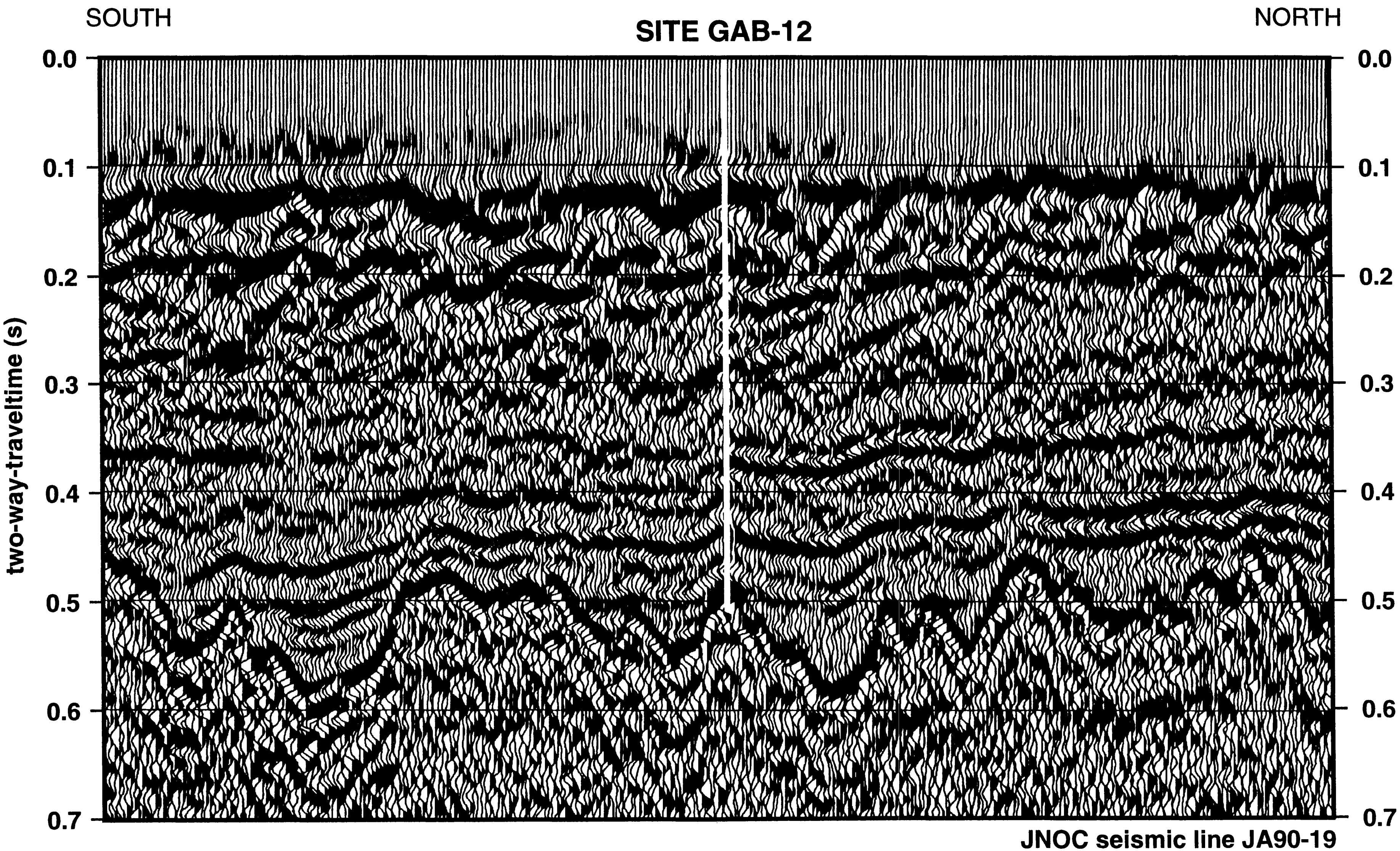
Contact Proponents:	Name/Address	Phone/FAX/Email
	Dr D.A. Feary, AGSO, Dept. Geology & Geophys., University of Sydney, Sydney 2006, AUSTRALIA	Phone: 61-2-351-2918; Fax: 61-2-351-0184 e-mail: dfeary@es.su.oz.au
	Dr N.P James, Department of Geological Sciences, Kingston, Ontario K7L 3N6, CANADA	Phone: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

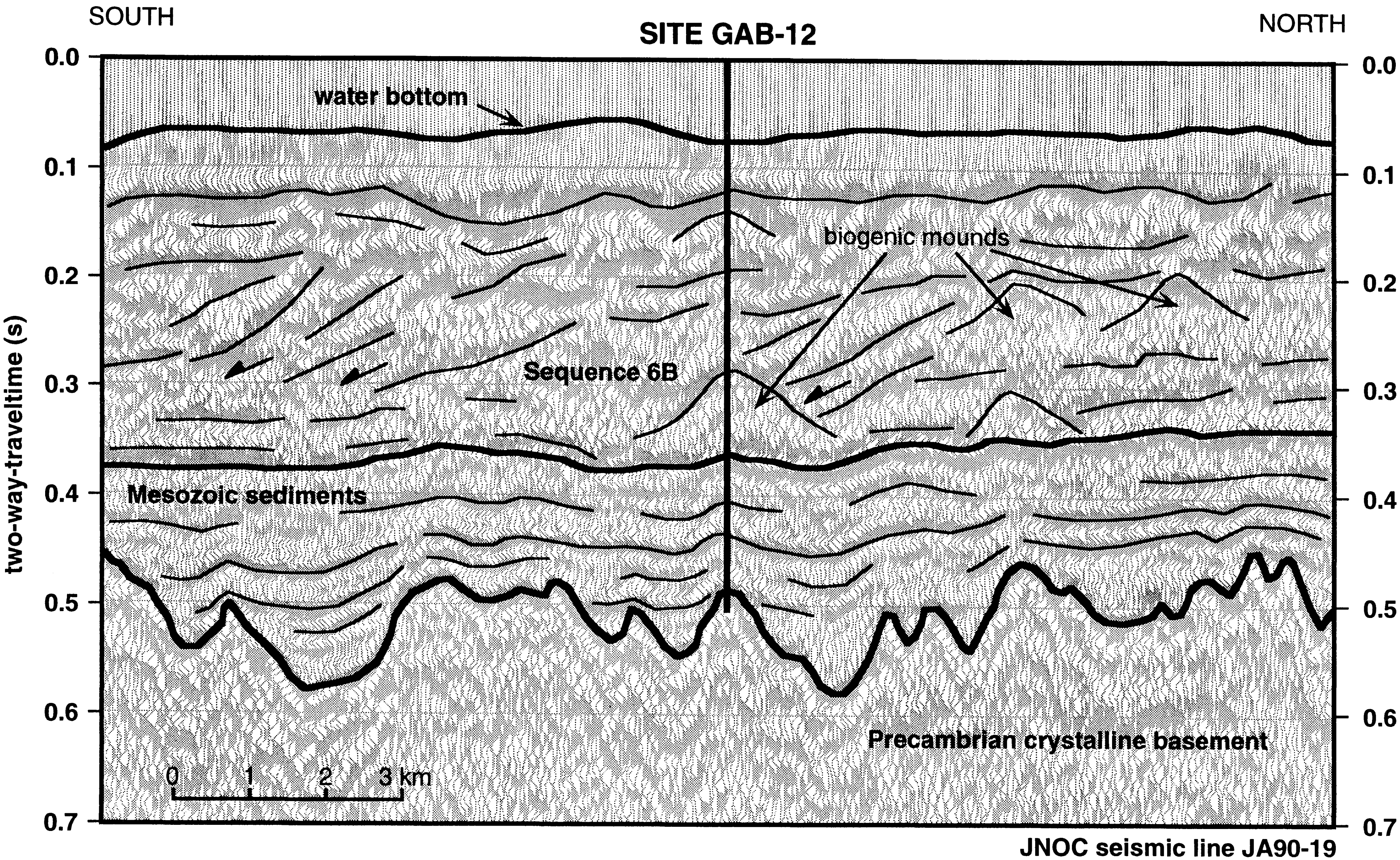
6.6 Site GAB-12

Site GAB-12 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.

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.


SOUTH
SITE GAB-12
NORTH
two-way-traveltime (s)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
JNOC seismic line JA90-19


SOUTH
SITE GAB-12
NORTH
two-way-traveltime (s)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
water bottom
biogenic mounds
Sequence 6B
Mesozoic sediments
Precambrian crystalline basement
0 1 2 3 km
JNOC seismic line JA90-19

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-12)	
Area:	inner Eucla Shelf, Great Australian Bight	
Lat./Long.:	32° 31' 32.4"S 127° 12' 26.8"E	
Water Depth:	42 m	
Sed. Thickness:	450 mS TWT; ≈540 m	
Total penetration:	455 mS TWT; ≈545 m	

	Sediments	Basement
Penetration:	450 mS TWT; ≈540 m	5 m
Lithology(ies):	370 m grainstone and wackestone; 170 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):

No.		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		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 JA90-19; cdp 12724 (SP 6402)

	Name/Address	Phone/FAX/Email
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	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