CRUISE PROPOSAL: AN OCEAN BOTTOM AND LAND SEISMOGRAPH SURVEY ON THE AUSTRALIAN NORTH WEST SHELF

BY

CLIVE COLLINS & CHAO-SHING LEE

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AGSO
AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION

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SUMMARY

During December 1995-January 1996 the Australian Geological Survey Organisation (AGSO) will conduct a seismic refraction survey of the North West Shelf. The AGSO research ship R/V *Rig Seismic* will deploy Ocean-Bottom Seismographs (OBSs) along five transects. Three transects will cross the entire continental margin, extending from the coast to beyond the continent-ocean boundary. These transects are located in the northern Carnarvon Basin, the offshore Canning Basin and the Browse Basin. The fourth transect will cross the Petrel Sub-Basin, and the fifth transect will cross the Vulcan-Ashmore Troughs.

The main objectives of the refraction survey are to: a) obtain the P-wave velocity structure of the major crustal elements along the transects so that depth conversion of the reflection profiles can be better constrained; b) measure the depth to basement; particularly in the deepest sections, and provide some constraints on the nature of the basement, c) identify major intra-crustal boundaries, and in particular, the crust-mantle boundary so that the crustal thickness can be mapped; and d) provide detailed velocities (including shear-wave velocities) within certain key features along the transects to determine the lithology, such as the presence of volcanics. These results will be used to constrain geodynamic and thermal modelling of the North West Shelf passive margin.

Fifteen OBSs from the University of Texas Institute for Geophysics (UTIG) at Austin, Texas, and four OBSs from the National Taiwan Ocean University, (NTOU) at Keelung, Taiwan, will be deployed. Six land seismic recorders will be placed onshore at the ends of the traverses to extend the maximum shot-station offsets and to provide control at the onshore ends of the traverses. The *Rig Seismic's* air-gun array will be used as the seismic source for both the OBSs and land recorders.

A total of 90 OBS stations and 10 land stations are planned for this survey. Based on the results of ray-path modelling, the OBS stations will be deployed along the five transects with a spacing between 5 and 30 km. In addition, we will also deploy OBSs along a short strike line through the proposed ODP drill sites in the Argo Abyssal Plain, and possibly around a salt structure in the Petrel Sub-Basin. The total time required to finish this survey, including transits and port calls, is 40 days.

INTRODUCTION

It is increasingly recognised that on many continental margins several episodes of rifting and sag, which can be related to a variety of different extensional styles and episodes, are commonly involved in modifying the continental lithosphere over periods of 300 Ma or more prior to break-up. Understanding the mechanical evolution of continental margins and their basins is essential for offshore environmental and resource management.

During the last 5 years, AGSO's Continental Margin Program commenced a major program of regional deep seismic reflection acquisition (~ 50-100 km grid and 12-16 seconds of two-way travel time) over all the main basins of the North West Shelf (AGSO North West Shelf Study Group, 1994; Figure 1). Currently about 40,000 km of deep seismic data has been collected, and provides a unique data set for imaging the gross geometry of crustal structures and features that have controlled the development of the margin and its basins. However, these images are in two-way time, and because the reflection method provides only poor constraints on seismic velocity, particularly at depth, conversion of seismic images to a meaningful true-depth section is problematic. Moreover, the lack of good velocity information also means that the lithology and compositions of imaged features are poorly constrained.

To overcome these problems and set the scene for major advances in our understanding of the North West Shelf, AGSO will use Ocean Bottom Seismograph (OBS) and land seismometer stations to record large-offset seismic arrivals from the *Rig Seismic* air-gun arrays (Lee and Collins, 1995).

AGSO will conduct the first OBS cruise on the North West Shelf in December 1995 - January 1996. The plan is to collect 5 transects of seismic refraction and wide-angle reflection data along existing deep crustal seismic reflection profiles as well as record data on land seismometer stations (Figure 1). These 5 transects (the Carnarvon, Canning, Browse, Petrel and Vulcan transects; Table 1) are widely spread along the North West Shelf continental margin in order to image the nature of deep-buried crust and map the Moho, basement and ocean-continent transition structures. The data will provide us with another dimension to our understanding of the deep crustal structure beneath the Australian continental margin and its relationship to major tectonic events.

The use of OBS is a new technique for AGSO and it will also be the first time that such technology and such an approach has been used in Australia. OBS are not commercially available, and only a few research institutes in the world have developed and built these instruments. After an extensive period of evaluation, the OBS designed by the University of Texas, Institute for Geophysics (UTIG) was found to be the most cost-effective instrument for AGSOs program, with great potential for future development, and with potential use for other applications (eg, ocean bottom earthquake monitoring, seismic tomography and magnetic observatory). France and Taiwan have both joined with UTIG to construct OBS and there is now a growing pool of these instruments.

AGSO has borrowed 15 OBS from UTIG and 4 from the National Taiwan Ocean University (NTOU) to carry out the survey. Both universities cooperated on an OBS cruise off Taiwan in August - September this year. This provided a model for the North West Shelf cruise, and Chao-Shing Lee and Jack Pittar of AGSO participated in it to gain the necessary experience in the use of OBSs. The majority of the instruments arrived in AGSO in October this year. Since then, the OBS team has undertaken cruise preparation.

The seismic source for this survey will be the air-gun arrays deployed by *Rig Seismic.* This array comprises twenty 150 cu. inch sleeve guns in a tuned array, with up to an additional 12 spare guns. All guns will be used whenever possible (a total of 4800 cu. inch; 78.6 litres), particularly at the furthest offsets. The minimum array size will be 20 guns (3000 cu. inch; 49.1 litres).

OBJECTIVES

The regional deep reflection profiles generally show excellent structural detail in the sedimentary section down to about 5-7 seconds, and in some areas good reflections down to the crust mantle boundary. However, in many areas, the basement, mid- to deep crustal structures and crust-mantle boundary is poorly defined, if at all. Moreover, without additional information which relates directly to rock type, such as seismic velocity, the interpretation of many deep reflection boundaries is uncertain. The seismic velocity is also needed to convert the reflection times to depths of boundaries. Such primary parameters as the total thickness of the sedimentary section, the variation of crustal thickness and the lithology represented by the deep seismic images (eg. are some deep reflective bodies sedimentary or volcanic?) have major implications for models of the tectonic structure and history of the North West Shelf passive margin.

The reflection method cannot give reliable velocities at depths below a few kilometres. This is primarily because of the relatively short length of the recording spread compared to the depths of the boundaries, the lack of coherent reflectors within basement, and the low energy of vertical reflections from deep boundaries. These limitations can be overcome by recording out to large distances from the shots with stand-alone recording systems such as OBSs and land refraction recorders. The reflected energy increases as the angle of incidence on the boundary increases at large distances, and these wide-angle reflections are generally more coherent at the lower frequencies recorded at these distances. Also, at sufficiently large distances, refracted energy is recorded which has travelled laterally through the crustal layers, thus providing a direct measure of the velocity within the layers.

To address the need for velocities and to complement the structural information in the reflection profiles, the major objectives of the refraction recording will be to:

- Obtain the P-wave velocities of the major crustal layers along 5 representative transects across the North West shelf passive margin, so that depth conversion of the reflection profiles can be better constrained,
- Identify the base of the sedimentary section, particularly in the deepest section where this cannot be identified in the reflection profiles,
- Identify major intra-crustal boundaries, and in particular, the crust-mantle boundary, so that changes in crustal thickness can be mapped,
- Provide detailed velocities within certain key features along the transects to identify the lithology, such as the presence of volcanics,
- Record S-wave velocities to constrain the interpretation in terms of the petrology, and
- To link the offshore and onshore crustal structure by deploying onshore recorders as well as the OBSs.

The refraction results will also be used by the Australian Geodynamic Cooperative Research Centre (AGCRC) Program III sub-project (Tectono-Stratigraphic Evolution of the North West Shelf) to constrain geodynamic and thermal modelling of the North West Shelf. The AGCRC will model each of the four main OBS transects as a representative section of each major compartment of the North West Shelf. In addition to the main objectives, the refraction results will have an input to resolving the following questions:

- The present and past relationship between the major crustal blocks, which are in part characterised by their velocity structure;
- The role of upper/lower crustal decoupling, which may be identified by lateral changes in intra-crustal boundaries;
- The nature of the crustal structure under the major depocentres and its influence on their formation;
- The post-break up thermal history of the margin, deduced from the crustal and sediment thickness, the presence of volcanics, and underplating;
- The existence of a Cretaceous "super-plume" (deduced from present day mantle velocities) and its role in the subsidence of the Exmouth Plateau.

Apart from the objectives listed above which are common to all transects, the refraction results will also target some specific questions on each transect. The Carnarvon transect will address the nature of the Enderby Terrace and the Lewis Trough, and in particular the basement structures underlying the Lewis Trough; also, the significance of the basement highs on the outer Exmouth Plateau (Stagg and Colwell, 1994). The Canning transect will address the nature and significance of the Bedout High, and the apparent inconsistency between the low gravity anomaly and lack of magnetic expression with the inferred presence of intrusives (Colwell and Stagg, 1994). The velocity structure along this transect should also provide data to explain the relative thicknesses of the Triassic and Jurassic sediments, and the significant (3 km) subsidence at 80 Ma.

The Browse transect was chosen so as to cross the entire basin, out the continent-ocean boundary. This will be compared to the only other line on the North West Shelf with substantial refraction data available (Line 119/4 in the Browse Basin; Symonds and others, 1994), which has an apparently different style of extension. The Petrel Sub-Basin has had a high degree of thermal subsidence over a period of 340 My; defining the nature of the basement, and apparent extreme attenuation of the crust, may help explain this event. Refraction data may also explain the significance of the central gravity anomaly in the basin, the nature of the high-displacement ramp margins, and the geometry and depth of origin of large salt diapirs. The Vulcan transect crosses the gravity expression of the proposed North West Shelf Mega-Shear; the velocity structure may define the nature of this feature.

OCEAN BOTTOM SEISMOGRAPH

AGSO has borrowed 19 OBSs to conduct this survey, 15 from UTIG and 4 from NTOU. These OBSs are of similar design (Nakamura and others, 1987) and a general description of them follows (Table 2):

The Pressure Vessel

The pressure vessel is a 43 cm diameter glass sphere made by Benthos and rated to a depth of 7000 m. It comprises two hemispheres which seal together by water pressure alone. The mating surfaces are finely ground glass and require no gaskets, etc. They must be aligned as delivered from the factory by means of a mark on both hemispheres, and only the original pair of hemispheres can be used with each other. Small chips on the edges of the surfaces are a common occurrence especially during the first deployments; the sphere will seal provided at least half the thickness of the mating surfaces remains intact. The thickness of the glass is about 1.3 cm.

The sphere is pierced by 6 drilled holes. Five are electrical connections: ground, serial communication with CPU and recording medium, clock communication, the release mechanism, and for optional hydrophone. One is a vacuum port for evacuating sphere and filling with dry nitrogen. There is a magnetic switch to wake up the sphere from outside after it has been sealed and another switch for resetting the back-up release clock.

The electronics and recorder assembly is mounted in the lower hemisphere by three bolts onto three rubber flanges. The hemispheres are strapped together with two stainless steel straps and screw fittings. The mating surfaces of the hemispheres are cleaned with solvents and lint-free tissues before alignment and assembly. A special putty tape from Benthos is wound around the outside of the join, and wide plastic insulation tape wound over that. The purpose of these is to prevent leakage while the sphere is near the surface before it is sealed by the pressure in deep water. Two other steel straps attach the sphere to a lower yellow plastic hemispherical outer shell. This has weights attached at the bottom so the sphere will float upright on the surface. The total weight of the sphere and its contents is 32 kg.

The sphere is attached to the anchor frame by three lengths of bungee chord. One end of each chord is looped over the triangle of stainless steel release wire on top of the sphere and the other end tied to the anchor.

Sensors

Three channels record the outputs from a 3-component 4.5 Hz Mark Products L15, gimbal mounted. seismometers They are mounted within a perspex cylindrical container glued to the base of the sphere and filled with high viscosity Dow Corning silicone oil.

A fourth channel is used to record an external hydrophone. This is useful for deriving the source wavelet from the direct water wave. In order to prevent the water leakage, a special deep water hydrophone is necessary.

Recording Media

The recording medium is either a 524 Mb disc drive (UTIG) or a 220 Mb disc drive (NTOU). Both the Toshiba 6 cm disc drives have the same dimensions. Being SCSI devices, more than one drive can be used in each OBS. The disc drives shut down completely between writes. To write 0.5 Mb to disc drive requires about 20 seconds, from spin-up to stop. Gaps in the data of approximately 20 seconds occur during the downloading from memory to disc drive. The data is downloaded from the drive after recovery of the OBS, or the whole disc drive can be swapped if spares are available.

Power Requirements

There are 9 power sources in the UTIG's OBS. These sources are supplied by lithium D cells, alkaline C and AA cells. The power source and quantity of the batteries are as follows:

1. CPU batteries - 9 alkaline D cells for each OBS would be sufficient for the entire survey. The quantity of the required batteries are 9x3x19 = 513 cells.

2. Disk Drive batteries - 8 cells per OBS are needed for the duration of the survey. 8x3x19 = 456 alkaline D cells are required.
3. Hydrophone batteries - Two 9v alkaline batteries should last for 4 deployments with a relay controlled on time of 36 hours for each of 15 UTIG units. 2x3x15 = 90 PP3 alkaline batteries are needed.
4. Power on/off relay battery - 2 are required per unit. With such little usage, the present installed batteries should last the survey. 2x3 AA cells needed.
5. Strobe battery - One set of 2 lithium D cells for each OBS unit. 2x19 = 38 lithium D cells needed.
6. Main release - One set of 4 lithium D cells should last the survey for each of 19 units. 4x19 = 76 lithium D cells needed.
7. Backup timer - One set of 3 lithium D cells should do the survey. 3x19 = 69 lithium D cells needed.
8. Radio Beacons - One set of 4 alkaline C cells should do the survey. 4x19 = 76 alkaline C cells required.
9. Radio direction finders - One set of 2 off PP3 alkaline batteries for each of 2 direction finders. six PP3 alkaline batteries needed.

Processor

The microprocessor used is a Tattletale 7 based on an 8088 chip, which uses a 14 bit A/D board. Anti-aliasing high-cut filters can be changed by unplugging resistor blocks from the main board.

Timing

The OBS clock is calibrated for drift with temperature when the OBS is constructed. There are two linear drift curves which need to be considered for each deployment: one at room temperature when the OBS is on the surface, and one at the sea bottom temperature when the OBS is deployed. The sea temperature at the bottom is around 2-4 degrees C. The OBS takes about 2 hours to equilibrate to temperature at the bottom. Also, there is a slight rise in temperature when the OBS is working compared to when it is sleeping.

The time is set when the sphere is bolted together, and then checked before deployment. Time is noted on recovery. The time standard for setting up is a GPS clock. The clock used for setting time and checking time must have output including milliseconds. The internal clock only returns times at 0.1 second intervals (but is accurate to milliseconds). Note that when it is set initially, it is only to the nearest second - no attempt is made to synchronise it with the time standard.

The CPU timing is by separate clock, so that the sample intervals may not be correct in terms of real time as defined by the main clock. There are procedures in the post processing routines which correct for this discrepancy.

A backup clock is provided for the release mechanism. It is set to release after a certain period of time. It increments in 1 hour increments. To test it, this can be changed to 1 second increments so that it can rapidly go through its time period. It has a separate power supply.

Anchor

The anchor is made from welded water pipe. It is a square frame with a ring mounted centrally to hold the sphere. Short spikes on the bottom may be used to couple to the sea floor. It weighs 50 kg.

Release Mechanism

The only release mechanism is by electrolytic dissolution of a stainless steel wire triggered at a preset time by the CPU. A backup clock is provided in case of failure of the CPU and can be set to an independent time of release if required. A few milliamps is required to dissolve the wire, which takes about 4-5 minutes.

The stainless steel wire is 90 kg breaking strength fishing leader wire (about 2 mm diameter) formed into a triangle approximately 7 cm to a side. It is covered by special sealing heat-shrink, except for two small sections which are left bare. The wire is made into a closed loop by twisting together and soldering after thorough cleaning with phosphoric acid, and attached to a lead which is plugged into one of the ports through the sphere. Note that the three bungee chords are pulled as tight as they will stretch and exert a very large force on the steel triangle; the triangle breaks catastrophically when it thins enough from dissolution.

The circuit is completed through the sea water by the ground wire coming through the sphere. It is looped under one of the steel straps holding the sphere to increase the surface area. Note that this release mechanism will not work in fresh water.

Deployment

Preparation for deployment consists of programming, clock setting, drift correction, bolting electronics/recording assembly to lower sphere, strapping both halves of sphere together, sealing outside, evacuating and flushing with dry nitrogen (repeated 2-3 times), strapping plastic lower protective hemispherical base, tying to anchor with bungee chords and stainless steel triangle, attach wiring for dissolving the link and the ground wire.

When prepared the OBS is lowered overboard by crane or A frame. As it touches the water it is released by pulling out a pin from a special mechanism. It should not be dropped into the water, nor released too late as it may tip over. If it does, it has been observed to right itself as it sinks. It sinks at about 1 m/s.

OBS deployment and recovery will be done from *Rig Seismic* during the North West Shelf cruise. Because we are not shooting any reflection profiles and there is no long streamer towing behind the ship, it will be possible to deploy and retrieve the OBS, and the shooting and transiting between sites can be done at the fastest possible speed.

Recovery

After release of the OBS at the seabed, it rises at approximately 1 m/s. The sphere contains two strobe lights which turn on at release time. A radio transmitter is activated when the OBS reaches the surface; a hand held receiver with a directional antenna is then used to locate the OBS. A red flag is attached to the antenna, if the unit is planned to be recovered during the day time. This assist in finding the OBS, but may be a source of noise if there are strong bottom currents. The appearance of the OBS at the surface is usually within minutes of the predicted time.

The OBS is recovered using a net on a pole. Alternatively, they can be recovered from a Zodiac; two people can easily lift it on board. After recovery, the clock correction is obtained through the sphere and any pressure differential is released through the vacuum port. The sphere is opened, and data is either transferred onto a Sun workstation or the drive pulled out and replaced with an empty one.

Reliability

All OBSs were recovered in the Taiwan experiment. The release mechanism is extremely reliable, however, careful preparation is required and all mechanisms need to be thoroughly checked out. They are hard to see in rough seas, when radio location is also difficult. They are easiest to locate at night because of the strobe lights. Leakage into the sphere may occur and is obvious from the outside. It is rare, and so far has not caused the loss of any OBS.

Modifications

During the Taiwan experiment, we have learned that whenever the plan has changed due to the weather or other ship schedule factors, the prepared OBSs have to be opened to re-set the backup release timer (the normal release timer can be re-set externally), and to turn off the hydrophone batteries. It takes time to re-open and seal the OBS. In order to solve these problems, Jack Pittar has suggested the following modifications:

Backup Release Timer - Another magnetic reed switch has been mounted on the backup release board, just to the right of the liquid crystal display. It is quite obvious from outside that it belongs to the backup release board. The possibility of incorrect identification is much less than the present problem of someone pressing the reset switch instead of the wake up switch! The reed switch is mounted in the same manner as the present wake up switch, and run wires to the present reset switch.

Hydrophone Batteries - We have installed a push-fit clip for each battery so they can be mounted on the aluminium plate of the electronics unit, beside the motor and the logic relays on the relay board. This will allow the inclusion of the hydrophone batteries in the testing schedule carried out on all the other batteries. Care will be taken to not obscure the mounting or removal of the disk drive. The usual 9v battery clips could be wired directly to the board. Extra pins can be inserted in the connector that goes to the serial communication penetrations to get the power to the hydrophone amplifier.

ONSHORE SEISMIC RECORDER

Six frequency-modulated analogue tape recording systems developed by AGSO (Finlayson and Collins, 1980) will be deployed at up to twelve recording sites (Fig. 1). These portable recording systems are based on modified Precision Instruments (PI) tape decks. The recording medium is a ½ inch 2200 m magnetic tape, which gives a maximum continuous recording period of 16 days. The recorders are powered by a sufficient number of external 12 volt batteries to record for the full duration of each tape.

The sensor is a single vertical component Willmore Mk II seismometer with a natural frequency of 1.5 Hz. The seismic channel is recorded at two gain levels 24 dB apart. A 6-100 Hz bandpass filter is applied to the signal before recording. A coded clock signal is recorded on a third channel, and time signals from the Omega radio navigation facility in Victoria are recorded on a fourth channel. The clocks are synchronised to the radio time standard. The clock errors at the start and finish of the recording period are noted, and from these the clock drift is derived. The clock drift can also be derived later from analogue playouts of the timing channels.

Four spare recorders based on modified Akai tape decks will be available as replacements, and will be deployed as extra stations if possible. These use ¼ inch magnetic tape with a maximum recording period of 4 days. The sensor is a single vertical Mk III Willmore seismometer with a natural frequency of 1.5 Hz.

CRUISE PLAN

Ray Path Modelling

All OBS transects are coincident with previous AGSO regional reflection profiles. This allows direct input to the interpretation of these profiles, and also makes possible some pre-cruise modelling of these lines for the OBS survey. Approximate velocities were used to depth-convert the two-way time reflection sections along these transects. The ray-paths and travel-times expected at each proposed OBS site were then modelled (by A. Goncharov, AGSO) using the ray-tracing program MacRay (Luetgert, 1992). This modelling will determine the optimum locations of the OBSs necessary to achieve the cruise objectives, given the number of OBSs and time available. Representative examples of the modelling and results are shown in Figures 7-12.

Time Requirement

Based on the results of the ray path modelling, we have prepared a plan for 90 OBS stations along 5 transects on the North West Shelf (Table 1). These are:

- Carnarvon Transect - 20 stations in 2 segments,
- Canning Transect - 20 stations in 2 segments,
- Browse Transect - 20 stations in 2 segments,
- Petrel Transect - 15 stations in 1 segment, and
- Vulcan Transect - 15 stations in 1 segment.

The time requirement is about 6 days to conduct a 500 km transect with 20 stations in 2 segments (ie, Carnarvon, Canning and Browse transects see Table 3 for time estimation) and about 4 days to conduct a 300 km transect with 15 stations in 1 segment (ie, Petrel and Vulcan transects see Table 3 for time estimation). Therefore, a total estimate of the time requirements are as follows:

- Leave Port Headland and transit to the Carnarvon transect — 0.5 days
- Data acquisition on the Carnarvon transect — 6.0 days
- Transit to the Canning transect — 2.5 days
- Data acquisition on the Canning transect — 6.0 days
- Transit to the Browse transect — 1.5 days

• Data acquisition on the Browse transect	6.0 days
• Transit and port call at Broome	2.5 days
• Transit to the Petrel transect	2.0 days
• Data acquisition on the Petrel transect	4.0 days
• Transit to the Vulcan transect	1.0 day
• Data acquisition on the Carnarvon transect	4.0 days
• Transit to Perth	4.0 days
	40 days.

LAND SURVEY PLAN

The crustal thickness along each traverse increases to normal continental values of 30-40 km as the land is approached. To properly define the crustal thickness, large offsets are required to record refracted arrivals from the crust-mantle boundary as first arrivals. This offset is around 150 km for normal continental crust. To achieve these large offsets at the landward end of each traverse, individual seismic recorders will be placed at sites onshore and as far as possible in line with the offshore traverses (Fig. 1).

These stations will record long-offset wide-angle reflection and refraction arrivals from the air-gun shots along the OBS traverses which will extend the traverses onshore and link the onshore and offshore crustal structures. The data recorded on the land stations will be reversed by the OBS data.

The recorders will be deployed by vehicle where possible. However, because it is the wet season the locations of the stations will be restricted by the available all-weather roads. It is expected that the Kimberley stations will be deployed by light aircraft because of the lack of all-weather roads in the area. These stations will be deployed adjacent to airstrips. Previous experience recording offshore reflection profiles within the Browse Basin on stations located on the Kimberley Block showed that these sites will successfully record seismic arrivals to over 200 km, and in some circumstances out to 300 km (Collins and others, 1995; Symonds and others, 1994). The positions of the sites will be determined by GPS.

DATA PROCESSING PLAN

Data Processing

The OBS position on the sea floor is derived from water-wave arrivals of nearby shots, and the known shot positions. The ship should traverse the OBS position firing its air guns, and preferably traverse it orthogonally as well. The arrivals are picked by an automatic picker from the data which takes into account the waveform to decide where the first break is. It works in 80-90% of cases. The rest have to be plotted and the problem with the picks solved manually. If a hydrophone is recorded, this is used because of the good waveform.

The relative amplitudes and phase of the first arrivals of the water wave is also used to orient the horizontal components, if these are used. Residual clock corrections are also obtained from the shots provided the primary clock corrections have been made.

An interactive processing system for deriving the position, orientation, timing corrections, etc. (OBSTOOL) has been developed by Gail Christeson (UTIG) and Bertrand Toussaint (ORSTOM) on a Sun Sparc station. This system will be on board the ship to do all the preliminary processing. The majority of the data can be processed fairly readily some percentage will always give problems with timing.

The final output from the processing routines are SEG-Y files. Preliminary data processing will be carried out during the cruise. The data processing facilities will be connected by a stand-alone net work including 2 Sun Sparc-5 work stations, four 4-Gb hard disks, 2 exabyte tape drives, PCs, Macintosh and printer. The software running in the system will be OBSTOOL, Petroseis, SIOseis, Ray Path modelling and inversion programs (MacRay and Rayinvr), and Microsoft Office Packages.

Interpretation

The first and later arrivals are digitised on a digitising table or picked on screen. Interpretation using forward modelling by ray tracing is done on a Macintosh using program MacRay (Luetgert, 1992). This is entirely interactive, mouse/menu driven, and is a very rapid modelling procedure. A forward modelling and inversion program Rayinvr (Zelt and Smith 1992) will be used on the SparcStations for inversion. This program produces synthetics as well; the source signal is derived from the water wave. This program inverts all the data (ie. from all the OBSs on the traverse) at the same time.

STAFF REQUIREMENT

The Ship's complement will be the normal AGSO operational personnel, AMSA ship crew and an OBS task team. The OBS team include the following:

AGSO
Chao-Shing Lee
Clive Collins
Peter Petkovic
Alexey Goncharov
Jack Pittar
Philip Doolan

University of Texas Institute for Geophysics
Yosio Nakamura

National Taiwan Ocean University
Kai-Lai Shen

Sydney University
Alexander Kritsky.

The OBS team will be divided into two major groups to handle the operation and data processing task on board the ship. The team structure is as follows:

Operation	**Data Processing**
<u>Shift 1</u>	
P Doolan CS Lee	P Petkovic A Goncharov
<u>Shift 2</u>	
J Pittar KL Shen	A Kritsky C Collins

Y Nakamura (between Shift 1 and 2).

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Table 1: Location of Transects

The transects are listed in the proposed order of completion:

No.	Transect	Transect Length	Reflection Line Nos.	No. of Segments	Total No. of OBS	OBS spacing (km)
1	Carnarvon Transect	600 km	101R/09, 128/08	2	20	~ 30 km
2	Canning Transect	500 km	120/01, 120/02	2	20	~ 25 km
3	Browse Transect	550 km	119/06, 128/01	2	20	~ 27 km
4	Petrel Transect	300 km	118/20, 98R/02	1	15	~ 20 km
5	Vulcan Transect	250 km	100/03	1	15	~ 17 km

Table 2: Specifications of UTIG's OBS

MAKE	UNIVERSITY OF TEXAS INSTITUTE FOR GEOPHYSICS (UTIG), AUSTIN, TEXAS
NUMBER OF CHANNELS (n)	1, 2, 3 or 4, software selectable
SENSORS	3-comp gimbaled geophones + hydrophone. L-15B 4.5 Hz Mark Products, gimbal mounted L-22 2.0 Hz " " , not " " L-4s or larger must be deployed outside
PASS BAND	4.5-100 Hz for geophones; 3.0-100Hz for hydrophone
ALIAS FILTERS/FILTER ROLL-OFF	selectable, plug in resistor blocks -24 dB/octave

SENSITIVITY	2.1 nm/s (Mark Products L-15B geophone) 62 uPa (Benthos AQ-12 hydrophone) 1.0 mPa (OAS E-2PD hydrophone)
DYNAMIC RANGE	126 db theoretical, 112 db re rms electronic noise
A/D	14 bits plus dynamic gain ranging
CPU	80C88
SAMPLE INTERVAL (t)	1 - 106 ms at 1 ms steps
RECORDING MEDIUM	450 Mb Tandberg 1/4 inch tape (up to 525 Mb possible); 200 Mb Connor HD.; 203 Mb Toshiba Toshiba MK2224FB HD; 500 Mb ToshibaMK2428FB HD.
ACQUISITION CAPACITY	TAPE: 22.5 t/n hours (t in ms)
DATA ACQUISITION MODE	continuous; short gaps during data transfer to recorder; pre-programmed on/off times, and any combination of recording parameters; triggered with long-term/short-term signal-level comparison
CONTINUOUS RECORD LENGTH	261,120 t/n (eg: 8m 42s @ 4 chan., 8 ms) 2,088,960 t/n with optional memory
TRANSFER RATE TO RECORDER	200 Kbytes/s
DATA GAP	8.1 s for 512 K; 47.9 s for 4 M - transfer to tape 22 s for 512 K transfer to Toshiba MK2224FB or MK2428FB disk drive
TEMPORARY DATA STORAGE	512 Kbytes (4 Mb optional)
DATA FORMAT	2 bytes/sample + 16 byte header in each block of 4 Kb; each 1Mb accommodates 552,240 samples of data
MAXIMUM DEPLOYMENT LENGTH/BATTERY LIFE	2 years dormant; 5 days acquiring on tape; 8 weeks acquiring on disk
CLOCK; TIMING ACCURACY	10 ms absolute; pre/post deployment clock calibration against standard signal & water wave arrivals
LOCATION ACCURACY	<10 m from analysis of water wave arrivals
ORIENTED ACCURACY	1^{o} from analysis of water wave arrivals

POWER SOURCE	24-37 size D lithium or alkaline cells or equiv.
TEMPERATURE LIMITS	
PRESSURE CASE	43 cm (17 inch) diameter glass sphere
WEIGHT AT DEPLOYMENT	85 kg (190 lb)
WEIGHT AT RECOVERY	35 kg (75 lb)
DIMENSION AT DEPLOYMENT	128x128x145 cm (50x50x57 inch)
ANCHOR	Frame made from steel pipes
MAXIMUM DEPTH	7000 m
RELOCATION AIDS	Radio beacon; Strobe lights; Flag
METHOD OF RECOVERY	Timed release from anchor controlled by 2 independent clocks; electrolytic dissolution of stainless steel wire.
TURNAROUND TIME	1-2 hr
NUMBER AVAILABLE	>30
OTHER COMMENTS	Gulf of Mexico, thick low-Q sediments - max range 80-100 km from two 32 litre air-guns. Other areas, good signals seen beyond 100 km. Shallow continental shelf - dependant on sea conditions because OBS at shallow depth is highly susceptible to wave noise.

Table 3. **OBS OPERATIONAL TIME REQUIREMENT**

500 km transect for 20 stations in 2 segments

Station	Program & Sealing (1.5 hr)	Transit & Deployment (15 nm @ 10 kt, + .25 hr)	Shooting (15 nm @ 5 kt)	Transit & Retrieve (15 nm @ 10 kt, + .5 hr)	Refurbishment (1 hr)
1	0.00	14.00	30.00	58.00	59.00
2	1.50	15.75	33.00	60.00	61.00
3	3.00	17.50	36.00	62.00	63.00
4	4.50	19.25	39.00	64.00	65.00
5	6.00	21.00	42.00	66.00	67.00
6	7.50	22.75	45.00	68.00	69.00
7	9.00	24.50	48.00	70.00	71.00
8	10.50	26.25	51.00	72.00	73.00
9	12.00	28.00	54.00	74.00	75.00
10	13.50	29.75	57.00	76.00	77.00

Station	Program & Sealing (1.5 hr)	Transit & Deployment (15 nm @ 10 kt, + .25 hr)	Shooting (15 nm @ 5 kt)	Transit & Retrieve (15 nm @ 10 kt, + .5 hr)	Refurbishment (1 hr)
11	60.50	79.00	95.00	123.00	124.00
12	62.50	80.75	98.00	125.00	126.00
13	64.50	82.50	101.00	127.00	128.00
14	66.50	84.25	104.00	129.00	130.00
15	68.50	86.00	107.00	131.00	132.00
16	70.50	87.75	110.00	133.00	134.00
17	72.50	89.50	113.00	135.00	136.00
18	74.50	91.25	116.00	137.00	138.00
19	76.50	93.00	119.00	139.00	140.00
20	78.50	94.75	122.00	141.00	**142.00**
					(6 days)

300 km transect for 15 OBS stations in 1 segment

Station	Program & Sealing (1.5 hr)	Transit & Deployment (12 nm @ 10 kt, + .25 hr)	Shooting (12 nm @ 5 kt)	Transit & Retrieve (12 nm @ 10 kt, + .5 hr)	Refurbishment (1 hr)
1	0.00	10.00	31.00	60.00	61.00
2	1.50	11.45	33.40	61.70	62.70
3	3.00	12.90	35.40	63.40	64.40
4	4.50	14.35	37.40	65.10	66.10
5	6.00	15.80	39.40	66.80	67.80
6	7.50	17.25	41.40	68.50	69.50
7	9.00	18.70	43.40	70.20	71.20
8	10.50	20.15	45.40	71.90	72.90
9	12.00	21.60	47.40	73.60	74.60
10	13.50	23.05	49.40	75.30	76.30
11	15.00	24.50	51.40	77.00	78.00
12	16.50	25.95	53.40	78.70	79.70
13	18.00	27.40	55.40	80.40	81.40
14	19.50	28.85	57.40	82.10	83.10
15	21.00	30.30	59.40	83.80	**84.80**
					(4 days)

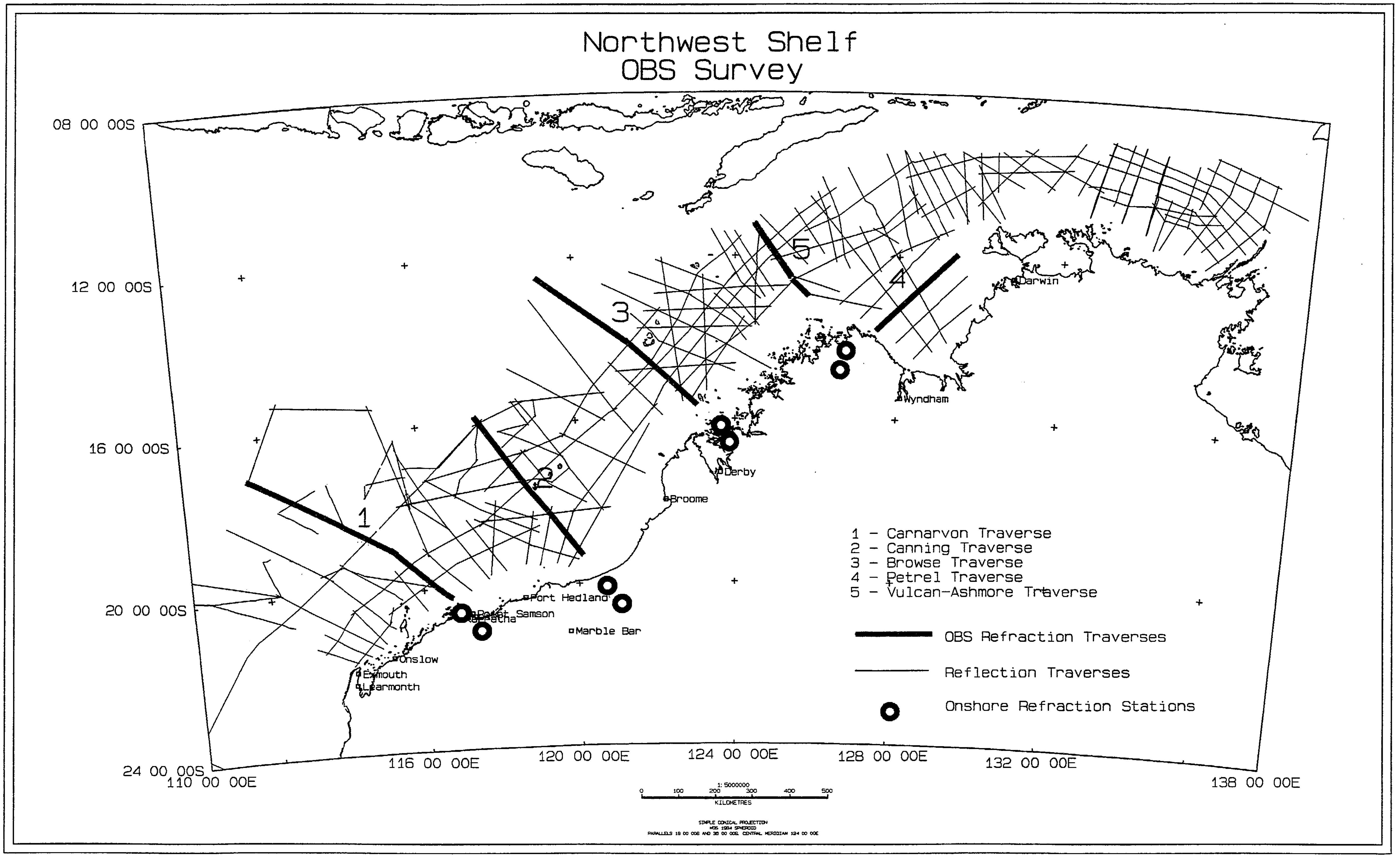

Figure 1. Location of traverses and recording stations

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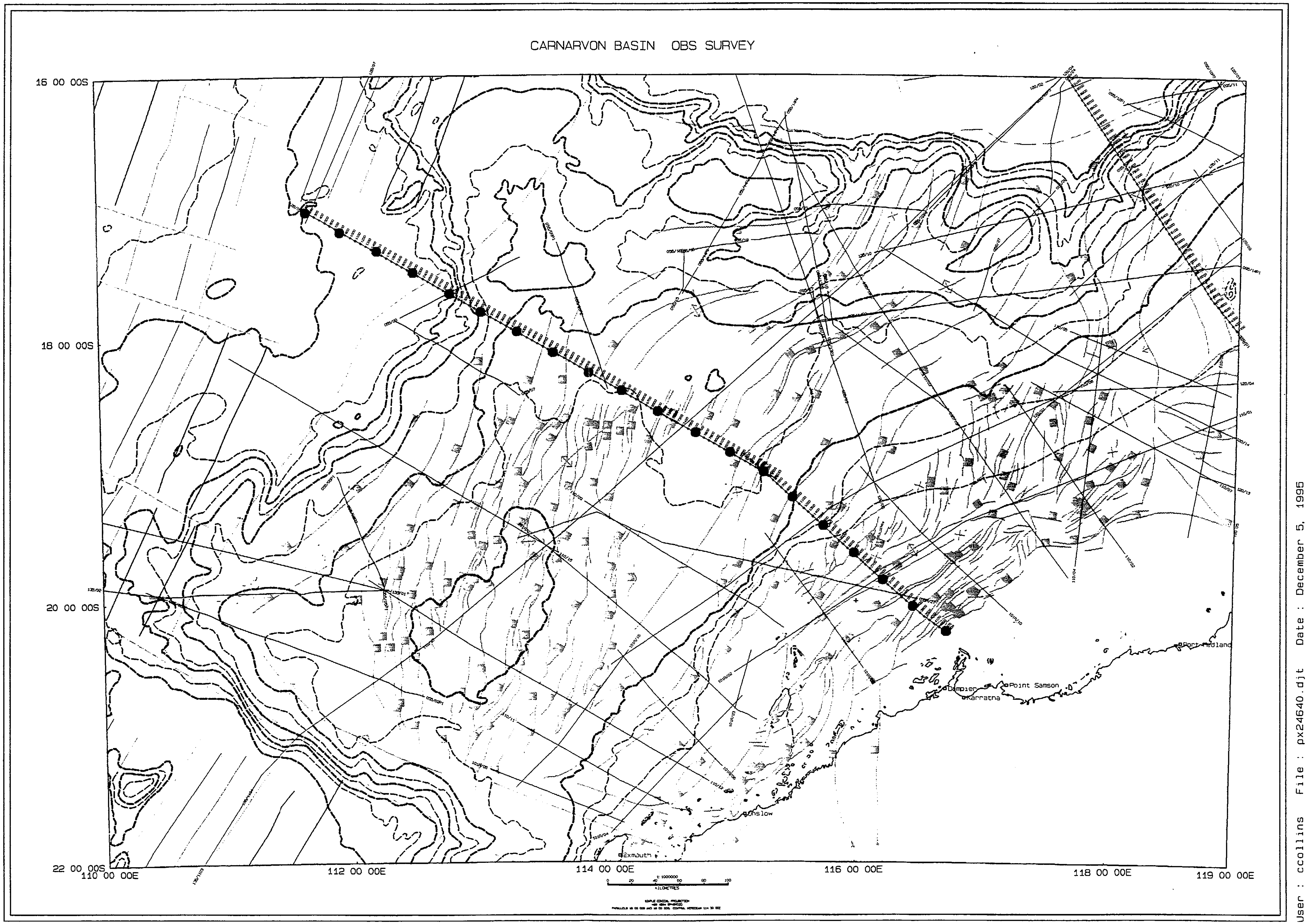


Figure 2. Proposed Locations of OBS on Carnarvon Transect

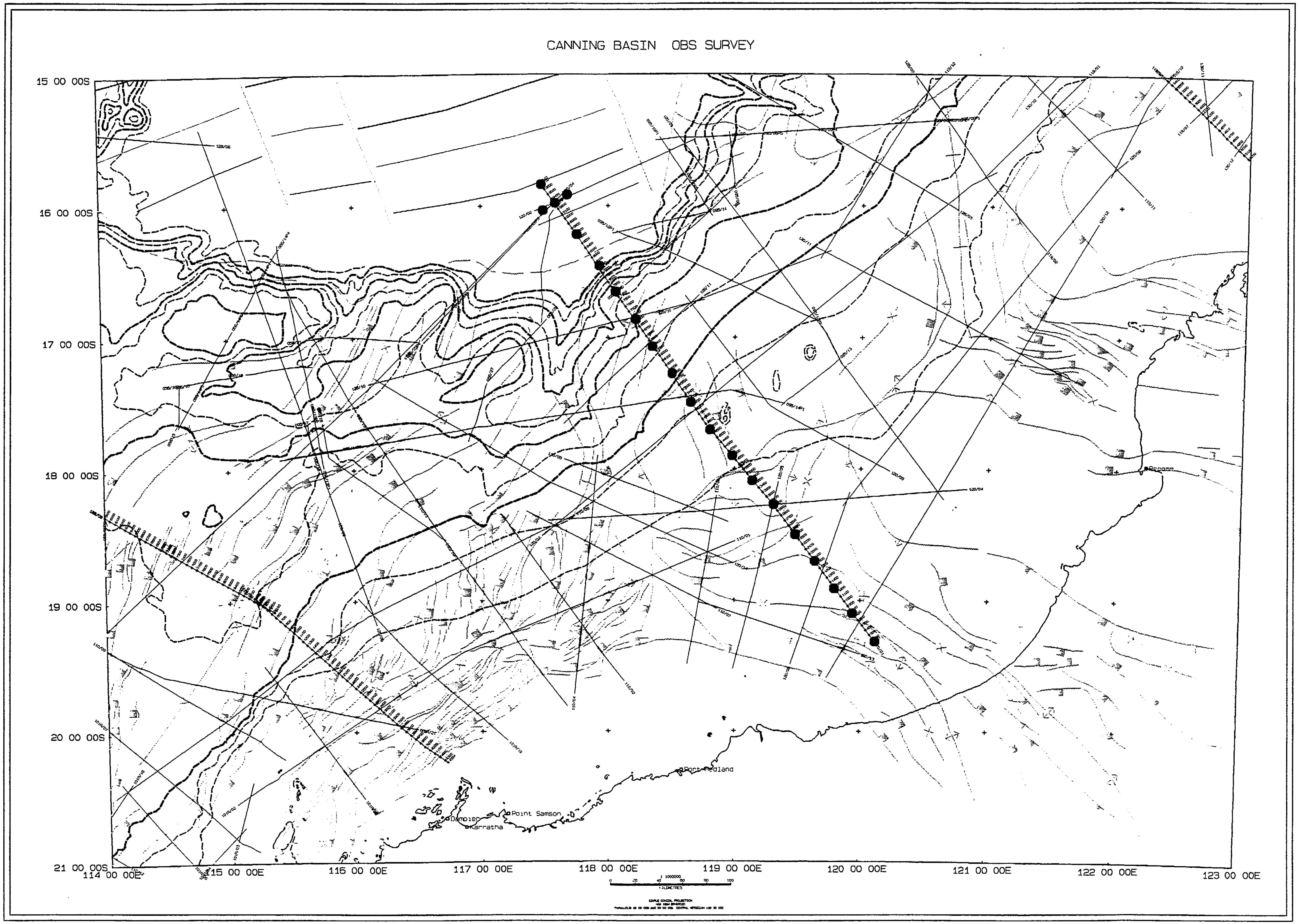


Figure 3. Proposed Locations of OBS on Canning Transect

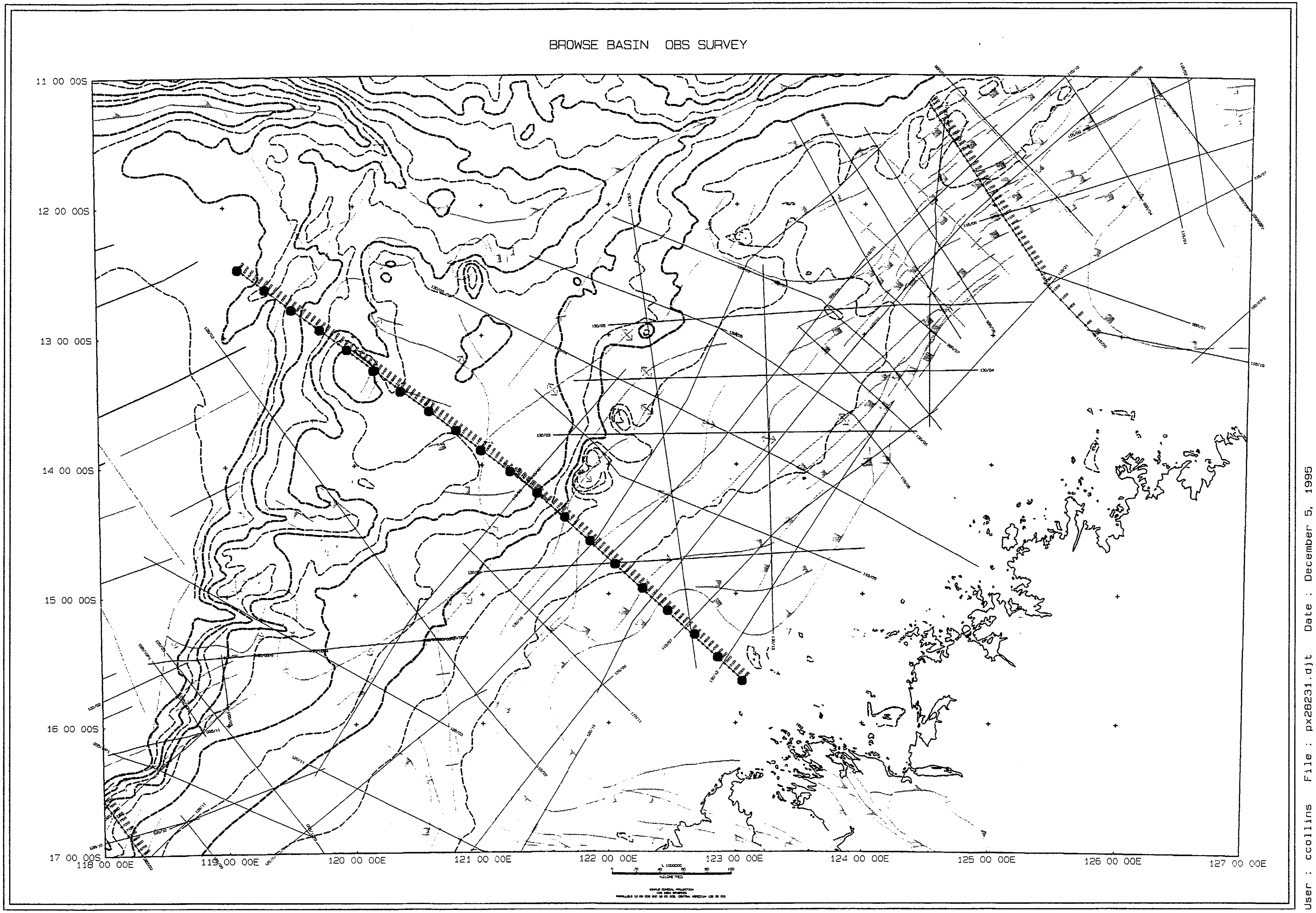


Figure 4. Proposed Locations of OBS on Browse Transect

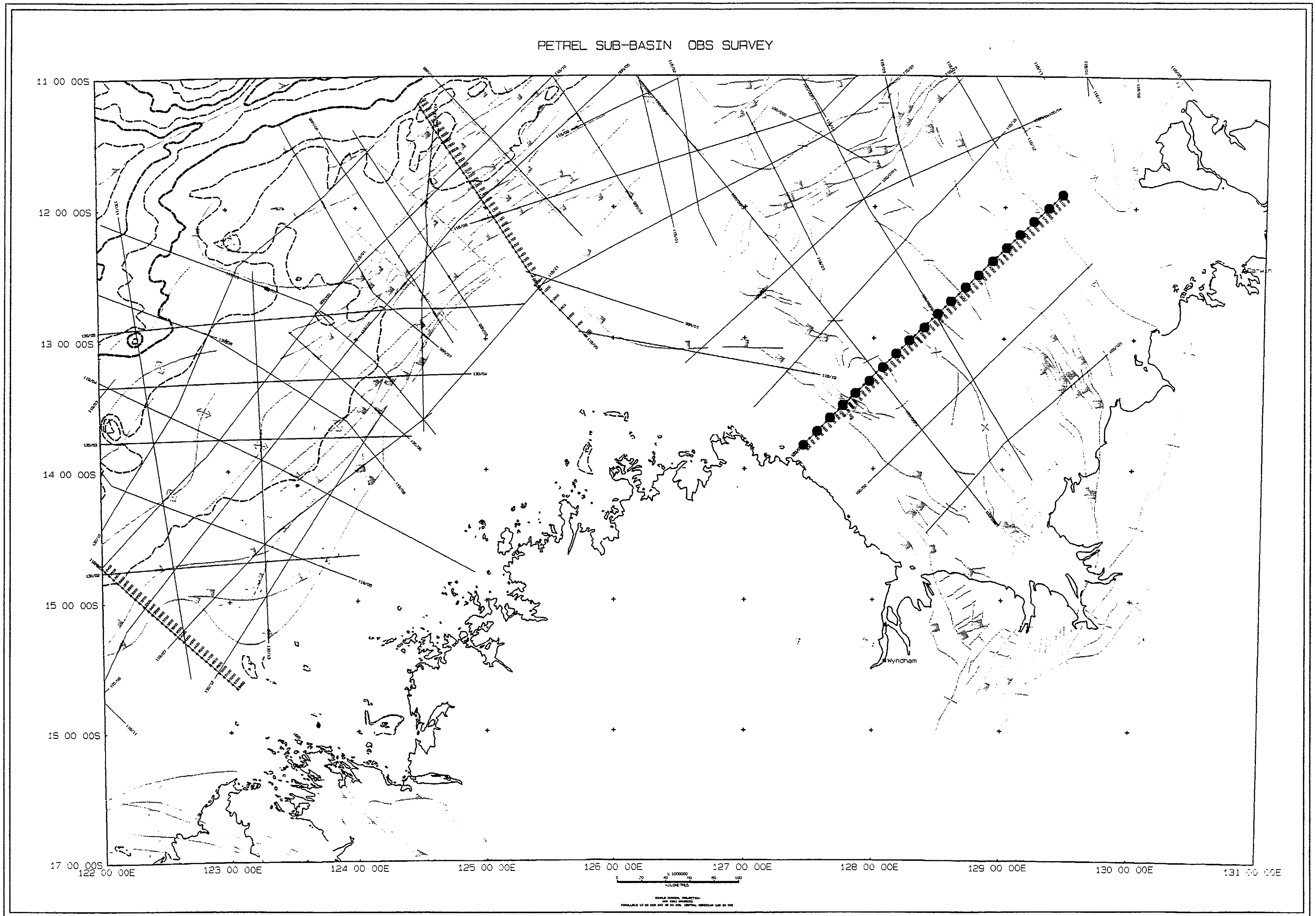
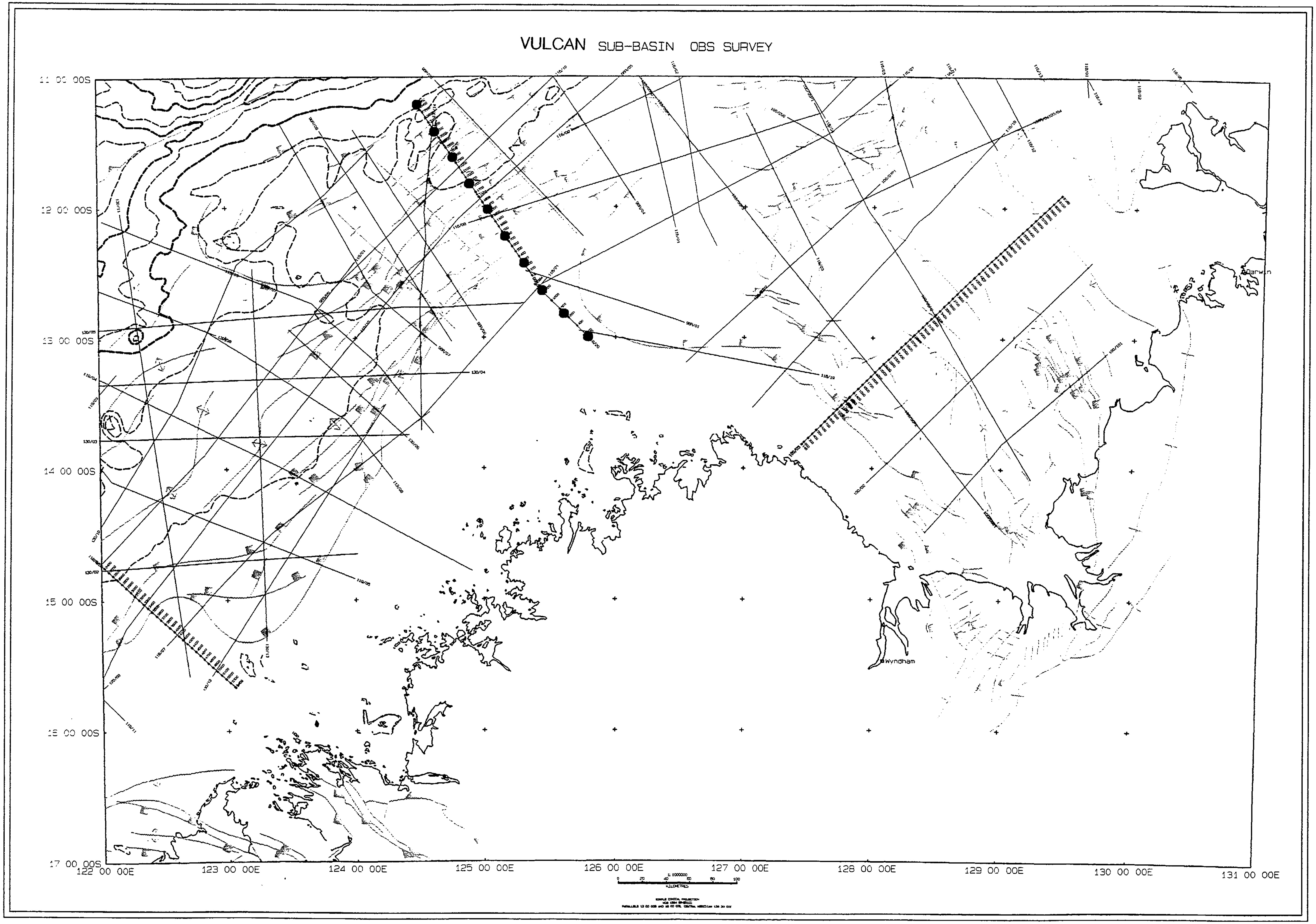


Figure 5. Proposed Locations of OBS on Petrel Transect



User : ccollins File : px512.djt Date : December 6, 1995

Figure 6. Proposed Locations of OBS on Vulcan Transect

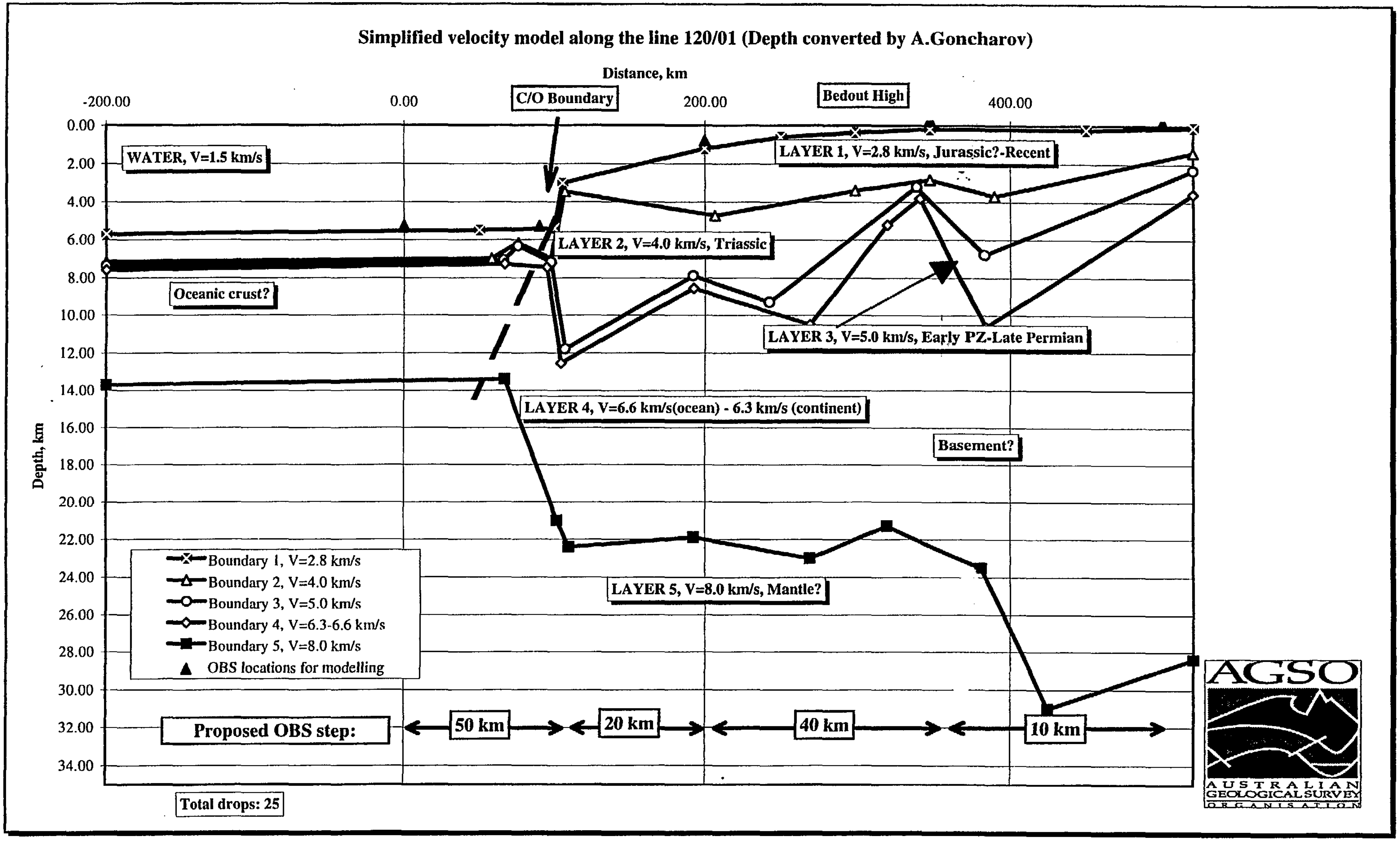


Figure 7. Simplified Velocity Model of Canning Transect and Proposed OBS Locations

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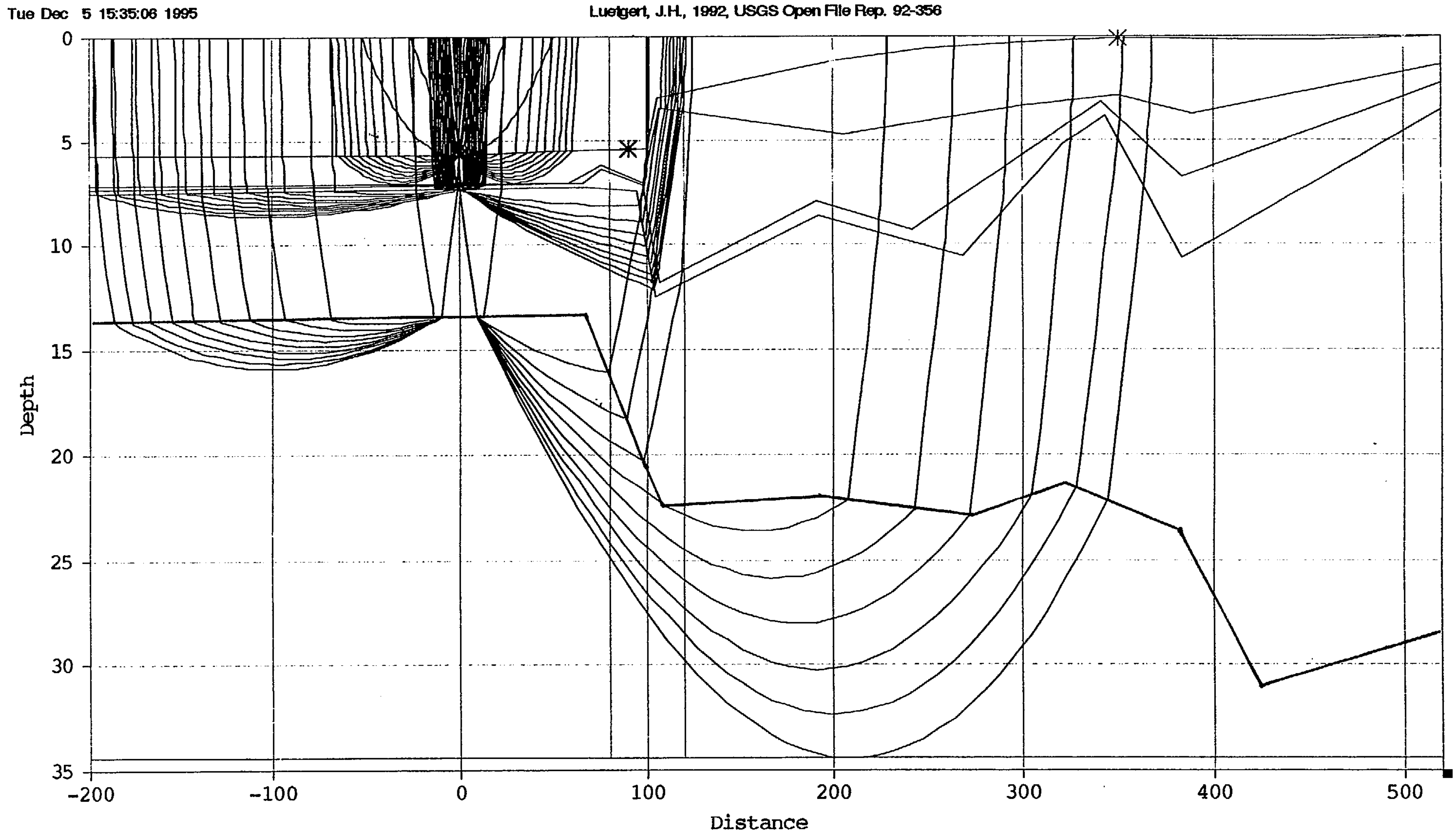

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Figure 8. Ray-paths to western-most OBS on Canning Transect

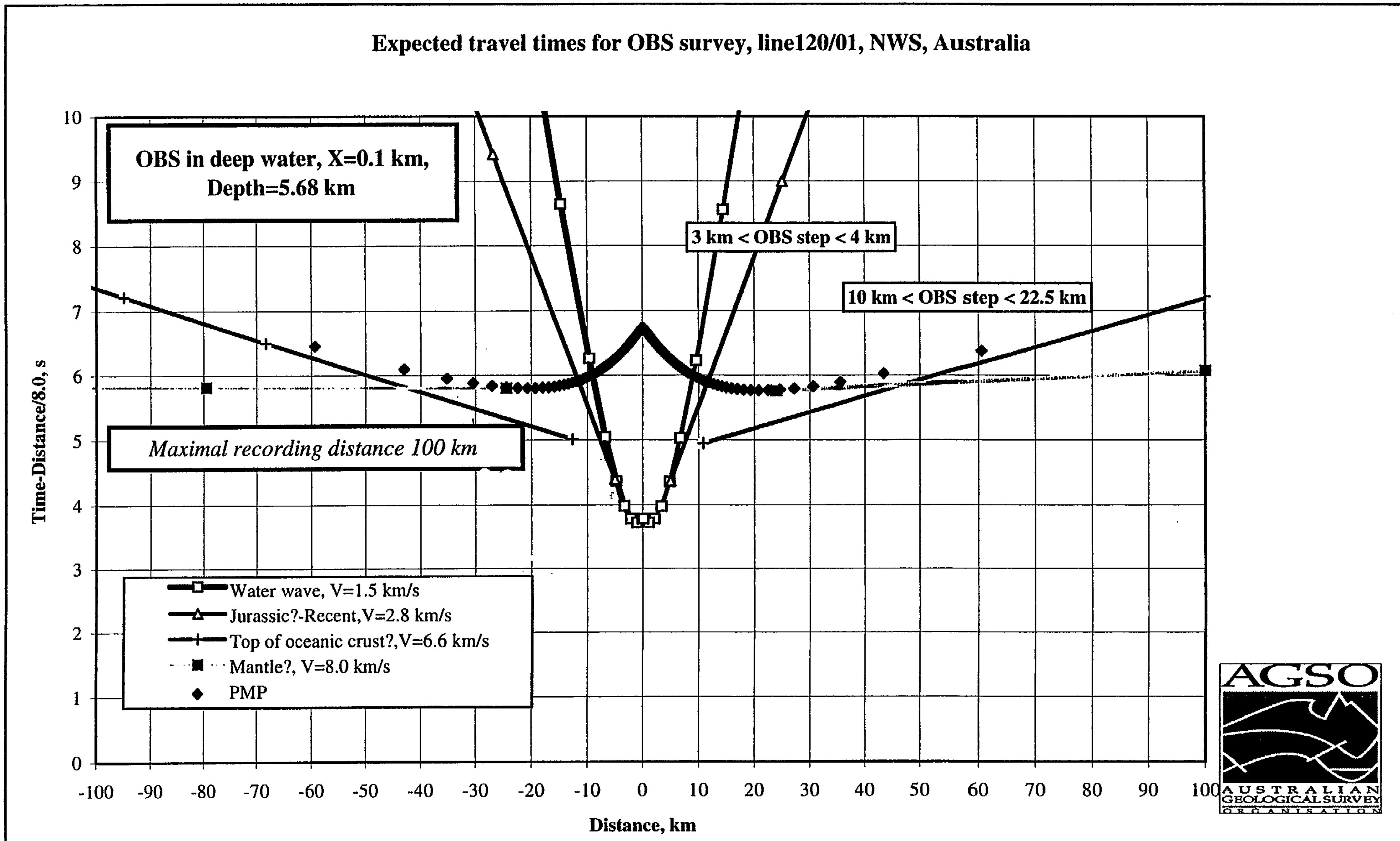

Figure 9. Computed travel-time curves (Distance = 0 km)

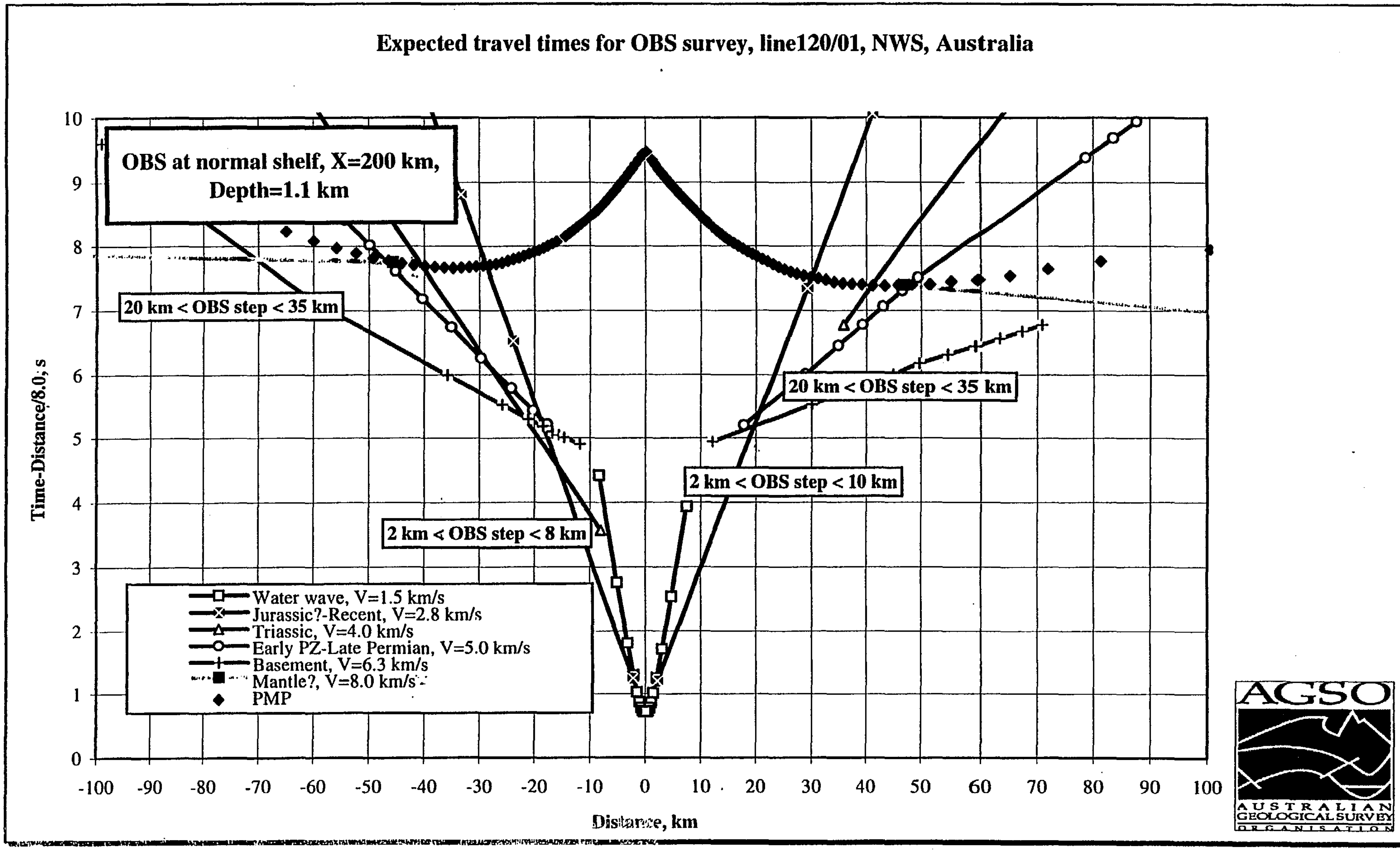

Figure 10. Computed travel-time curves (Distance = 200 km)

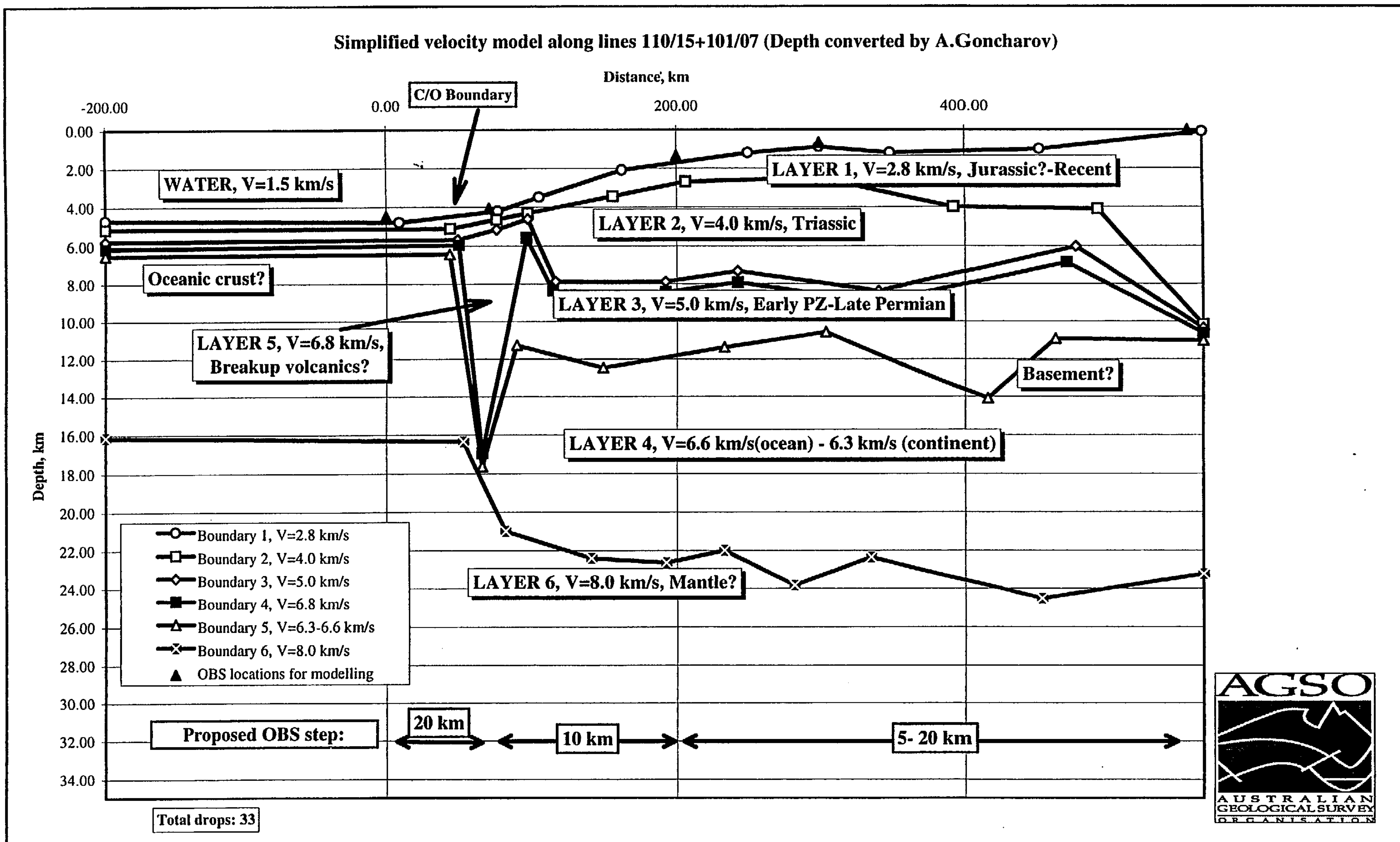

Figure 11. Simplified velocity model, Carnarvon Transect, with OBS locations

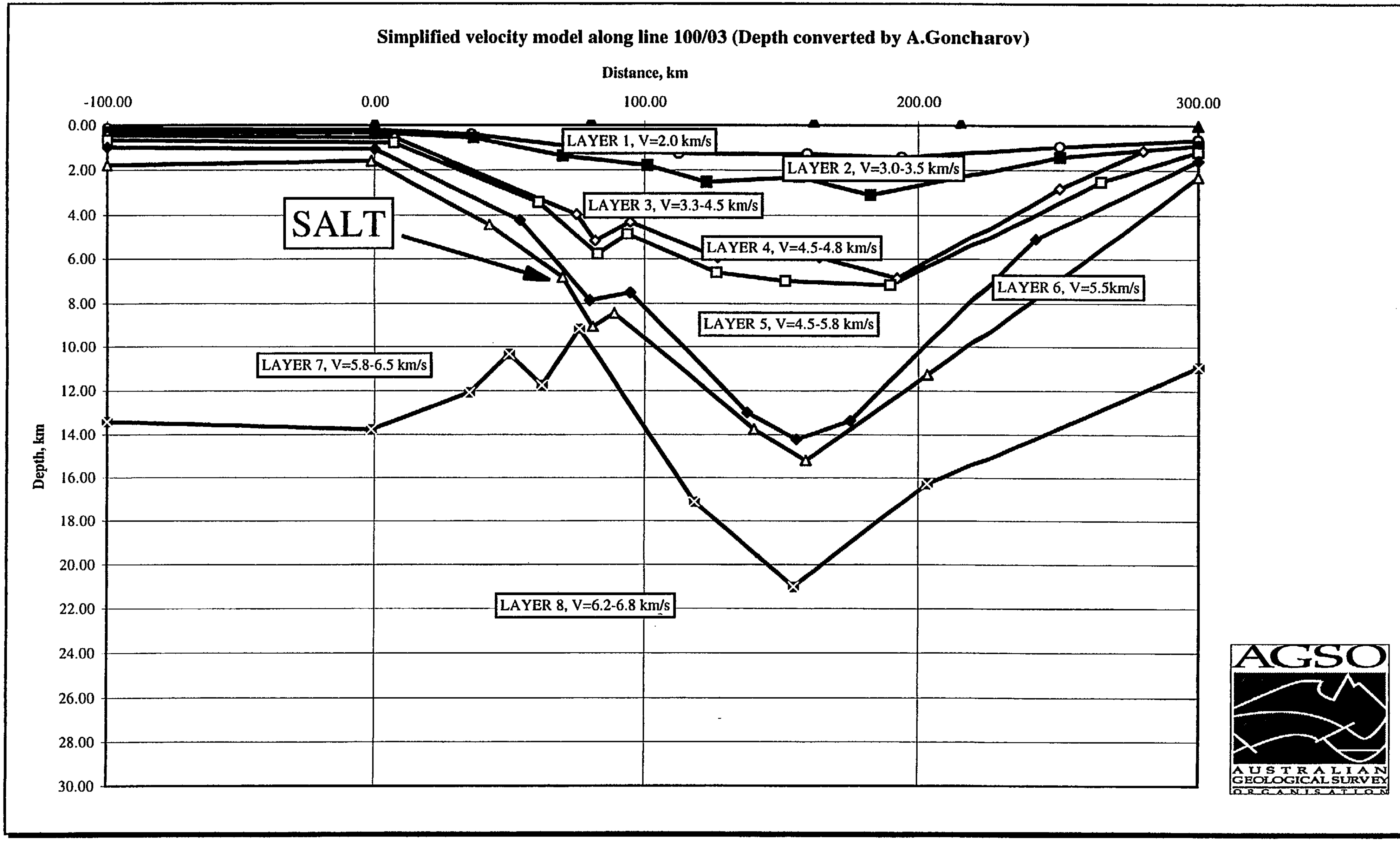

Figure 12. Simplified velocity model, Petrel Transect, with OBS locations