MASS, SALT, AND HEAT TRANSPORT
IN THE SOUTH PACIFIC

Louis Sherfesee III

NAVAL POSTGRADUATE SCHOOL

Monterey, California

THESIS

MASS, SALT, AND HEAT TRANSPORT IN THE SOUTH PACIFIC

by

Louis Sherfesee III

September 1978

Thesis Advisor: G. H. Jung

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Along both latitude lines, there was determined a net northward heat flow of 33 and 77 x 10^{12} cal/sec for the 28°S and 43°S latitudinal sections. Given the initial assumptions made, this slight northward heat transport is probably within the range of error for this study.

Mass, Salt, and Heat Transport in the South Pacific

by

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I. INTRODUCTION

The heat budget of the earth is the result of a net surplus of solar radiation received in the tropics, together with a net loss of heat in the polar regions. Since the temperatures of the tropics and the polar regions do not progressively get warmer and colder respectively, it was assumed that there was a poleward transport of heat from the equatorial area (Newmann and Pierson, 1966). This heat transport was a method of energy transfer. It was assumed that the bedrock structure of the earth accounted for negligible heat transfer through conduction (Sverdrup et al., 1942). The earth's atmosphere and world ocean were then assumed to be the primary energy transfer agents.

Coker (1947) wrote that the chief sources of heat for the sea were heat from the atmosphere by contact, absorption of radiation and condensation of water vapor. He also mentioned conduction through the ocean bottom, heat due to frictional currents and heat released through chemical and biological processes as negligible sources.

Neumann and Pierson (1966) in quoting Maury (1856) wrote: "The aqueous portion of our planet preserves its beautiful system of circulation. By it heat and warmth are dispersed to the extratropical regions; clouds and rains are sent to refresh the dry land; and by it cooling streams are brought from polar seas to temper the heat of the

torrid zone. To distribute moisture over the surface of the earth, and to temper the climate of different latitudes, it would seem, are the two great offices assigned by their Creator to the ocean and the air."

Dietrich (1963) stated that the external processes of heat transfer between ocean and atmosphere, as well as the internal processes of heat conduction in the ocean, are known only in rough outline.

At one time, the ocean had been thought of as the primary method of transfer. For over a century, there has been controversy over which system, air or sea, is the predominant mechanism for energy transport.

Maury (1856) and Ferrel (1890) emphasized the sea as the primary agent. Angstrom (1925) roughly equated the oceanic and atmospheric heat transport. Bjerknes _et_ _al_. (1933) and Sverdrup _et_ _al_. (1942) considered oceanic transport negligible as compared to that of the atmosphere. Jung (1952) questioned this and then stressed (Jung, 1955) that while oceanic transport of sensible heat is less than the atmospheric sensible and latent heat, it should not be considered as negligible.

It was proposed by Jung (1952) that the oceans with their accompanying current systems might be of more importance in the transfer of heat energy than thought at the time. He suggested that earlier studies such as Sverdrup _et_ _al_. (1942) had considered only the standing horizontal eddy, that is the Gulf Stream system with its associated

return currents, in their calculations. Jung proposed that closed vertical circulations in meridional planes could conceivably transport large quantities of energy, even when the velocities involved were minor. Jung followed this in 1955 with a detailed study in the North Atlantic Ocean which determined the heat transported by geostrophic ocean currents. Several studies (Budyko, 1956; Sverdrup, 1957; Bryan, 1962; Sellers, 1965; Vander Haar and Oort, 1973; Baker, 1978) with oceanic contribution to meridional transfer have followed, but with the exception of Baker, these studies have not utilized synoptic or nearly synoptic data for an entire ocean.

This study utilized a computer program developed by Greeson in his 1974 master's thesis. Two coast to coast South Pacific Ocean latitude sections obtained by the SCORPIO Expedition (1967) were used to determine a general geostrophic circulation and net heat flux measurements.

The geostrophic method provided a means for computing the field of relative (geostrophic) motion in a fluid from a knowledge of the internal distribution of pressure (Von Arx, 1962).

II. BACKGROUND

A. ENERGY TRANSPORT

The discussion of energy transport within either an atmospheric or oceanic medium starts with a general equation applicable to all fluid motion,

$$T^* = \int_S (\overset{(a)}{\rho U} + \overset{(b)}{\rho C^2/2} + \overset{(c)}{\rho\phi} + \overset{(d)}{P})\, V_n dS \ , \qquad (1)$$

where T^* represents the total meridional energy transferred normal to a vertical wall encircling the earth at a particular latitude, ρ is density, U is the internal energy per unit mass, C is the magnitude of the fluid velocity, ϕ is the potential energy per unit mass, P is the pressure, V_n is the component of the fluid velocity normal to the latitude wall at a given level in either air or ocean and dS is the differential area of the wall.

The total amount of energy transported across a complete latitudinal circle is composed of the transport due to (a) the advection of thermal energy, (b) the transport of kinetic energy, (c) the transport of potential energy and (d) the rate of work done by pressure forces.

As compared to the other terms, the transport of kinetic energy (b) is negligible (Jung, 1952).

The transfer of energy in the ocean is carried out by the water currents. Geostrophic equilibrium is assumed as one method to determine the magnitude of these currents. In addition the assumption of hydrostatic equilibrium in the vertical eliminates term (c) and (d) from equation (1). This then reduces equation (1) to the following form:

$$T_o^* = \int_o \rho_s U_s V_{ns} \, dO \; . \qquad (2)$$

The subscript "s" stands for seawater, and "o" is that part of our latitude wall, "S", slicing through the ocean. Now neglecting compressibility effects in water, $U_s = C_{ps} T_s$ where C_{ps} is the specific heat at constant pressure of sea water, and T_s is the temperature of sea water. Equation (2) may now be written as

$$T_o^* = \int_o \rho_s C_{ps} T_s V_{ns} \, dO \; . \qquad (3)$$

B. THE LEVEL OF NO MOTION

The dynamic method of utilizing oceanographic data includes the problem of locating a reference level of no motion. This reference level is necessary in order to determine absolute current velocities. Defant (1961), in discussing the difficulty of the problem, reported that the required data necessary to determine a zero level was largely lacking.

There have been several attempts to determine this level of no motion as listed in Defant (1961) and Baker (1978).

One early method was to assume this level was at a great depth in the ocean. The logic for this approach was the assumption that deep ocean waters were uniform with nearly horizontal isopycnal (equal density) and isobaric (equal pressure) surfaces. Absolute current velocities could be determined if the level was placed at a constant great depth.

Another method, offered by Jacobsen (1916), utilized the location of an oxygen minimum in the ocean as an identifier of the level of minimum horizontal motion. The reasoning behind this method was that the use of oxygen due to oxidation of organic matter takes place at all levels; therefore a minimum oxygen content would represent an area of minimum horizontal current replenishment. This method has some peculiar results which were brought out by various investigators (Rossby, 1936; Iselin, 1936; and Dietrich, 1936). In addition to unrealistic results, the assumptions of uniform distribution of organic matter and oxygen consumption were incorrect. This method of minimum oxygen levels necessarily coinciding with a level of no motion can be disregarded.

Parr (1938) considered thickness variation of isopycnal surfaces as a deterministic factor of a level of no motion. He equated minimal thickness distortion to minimal water motion within the layer.

Fomin (1964) took exception to Parr's method stating that the variation of current velocity in the vertical was a

function not only of isopycnal surface slope, but it also depended upon the vertical density gradient. Since Parr's method ignored the vertical density gradient, it would be possible to choose as a layer of no motion an undistorted thickness layer which was in reality a region of strong current velocity.

Hidaka (1940) proposed two different methods for determining the level of no motion. His first method was based on the salinity distribution. Fomin (1964) disagreed with this method saying that coefficients of turbulent diffusion in a layer of no motion did not remain finite as Hidaka had assumed and therefore Hidaka's resultant salinity characteristics bore no definite relation to the current velocity field.

Hidaka's second method depended on the continuity of volume and salt transport and the calculation of the vertical distribution of current velocity by the dynamic method. Fomin (1964) again took exception with Hidaka in that Hidaka's simplification of the continuity equation was not theoretically correct and also because this method led to a set of equations that could not be solved with the current accuracy of at sea measurements.

Defant (1941) determined the zero level based on the differences in dynamic depths of isobaric surfaces. Examination of dynamic height differences of isobaric surfaces of Atlantic station pairs resulted in Defant recognizing a relatively thick layer with horizontal uniform depth variation and small isobaric surface dynamic depth differences (Fomin, 1964).

Defant related this dynamic depth difference constancy to a constant vertical gradient component of current velocity within the layer. This layer was assumed to be nearly motionless and considered to directly adjoin the zero motion surface (Fomin, 1964). Baker (1978) evaluated the Defant method as one of the most reasonable, but stated that resultant current velocities had a low accuracy due to the accumulation of errors associated with the dynamic method.

Sverdrup et al. (1942) developed a method based upon the continuity equation; the level of no motion was determined by comparison of water mass transport above and below a horizontal reference surface. When the mass transport in the latitudinal area of study above the reference surface was equal and opposite in direction to the net mass transport below this surface, the reference surface was then a level of no motion. One difficulty with this approach was the requirement for data across the ocean from coast to coast necessary for dynamic calculations.

Stommel (1956) produced a method for determining the level of no motion using Ekman's concept of the oceans consisting of a wind driven surface layer of frictional influence and a deeper frictionless geostrophic layer. Surface wind stress produced divergence or convergence causing entry or exit of water from the subsurface geostrophic frictionless layer. This geostrophic layer will then suffer thickness changes. Water parcels within this layer will shrink or expand as they move poleward, producing a vertical component

equal to the vertical component at the bottom of the frictional layer produced by wind stress. This matching will occur at a level of no motion.

The final method of this summary is one introduced by Stommel and Schott (1977) based on the beta-spiral and a determination of the absolute velocity field from density data. Their theory was that because the horizontal component of velocity rotates with depth, absolute velocities could be found from observations of the density field alone.

This particular study of the Pacific Ocean uses the mass and salt continuity method proposed by Sverdrup _et al_. (1942) to determine the level of no motion along two latitudinal tracks (28°S and 43°S) across the South Pacific.

III. STATEMENT OF THE PROBLEM

The problem was to determine the heat energy transported by the South Pacific Ocean. To accomplish this objective necessitated the obtaining of thermal and salinity data in coast-to-coast latitudinal tracks from the surface to as near the ocean bottom as possible. It was also necessary to have a sufficient comprehension of the circulation pattern of the area.

Energy transfer is accomplished by several processes: large-scale advection, smaller scale eddy diffusion, and molecular diffusion. The primary mode of transfer is large-scale advection with eddy diffusion and molecular diffusion contributions being several orders of magnitude smaller. This investigation will neglect eddy and molecular diffusion.

The energy flux across any latitude line in the ocean is expressed by equation (3),

$$T_o^* = \int_o \rho_s C_{ps} T_s V_{ns} \, dO \; , \tag{3}$$

where the heat transport term determines the total energy flux across a vertical cross section of area dO within the ocean. The specific heat at constant pressure of sea water, C_{ps} , for this study has been assumed to have the value of unity.

Velocities were calculated with the formula derived by the Helland-Hansen and Sandstrom (1903) equation, and with the procedure from Sverdrup et al. (1942). The procedure utilizes the assumption of geostrophic equilibrium within the ocean. Jung (1955) pointed out that the geostrophic balance assumption appears valid for large-scale motion outside the equatorial region. It is therefore applicable for the area of this study.

In order to calculate geostrophic velocity differences between consecutive depths and between adjacent pairs of stations, dynamic heights were first computed. The equation

$$V_1 - V_2 = \frac{10C}{L} (D_A - A_B)$$

was used, where $C = (2\Omega \sin\phi)^{-1}$, Ω is the earth's angular speed, θ is the latitude, L is the horizontal distance between stations A and B, and D_A and D_B are the dynamic heights (or depths) of the two stations (Greeson, 1974).

The reference level or level of no motion must be established prior to using this method. To determine this depth level, there must be a zero net transport of both water mass and salt across the entire latitudinal slice of ocean, $\int_o dO$:

$$\int_o \rho_s V_{ns} \, dO = 0 ,$$

$$\int_o \rho_s S V_{ns} \, dO = 0 ,$$

where S here is salinity in parts per thousand.

The mass balance was the primary tool for determining the level of no motion. As will be seen later, however, there was little depth difference between levels balancing the mass and salt transports. After a level of no motion was determined, the heat flux across the associated latitude section was calculated.

IV. PROCEDURE

A. DATA SOURCES

This study dealt with the area of the South Pacific Ocean shown in Figure 1. Two latitudinal oceanographic sections were supplied by the SCORPIO Expedition, USNS Eltanin Cruises 28 and 29, 12 March - 31 July 1967 (WHOI Reference 69-56). The two latitude sections were at approximately 28°15'S and 43°15'S. Figure 2 is a photograph of the USNS ELTANIN which collected the oceanographic data. In planning the SCORPIO Expedition, the two east-west tracks had been selected for the following reasons: "observations of good quality in the central area were scarce and in order to have a general knowledge of the world ocean some attention had to be given to this immense area; this area also includes some of the deepest of the ocean trenches; and ... the study of deep circulation in the world ocean could not proceed without a systematic survey of the deep-water characteristics in the South Pacific, which is the largest of the world's oceans" (WHOI Reference 69-56).

Cruise 28 had an easterly track starting off the east coast of Tasmania. Station 1, Cruise 28, was occupied on March 12, 1967 and the last station of the track, Station 78, on May 8, 1967. Cruise 29 had a westerly track, originating off the west coast of Chile, with its first station, number

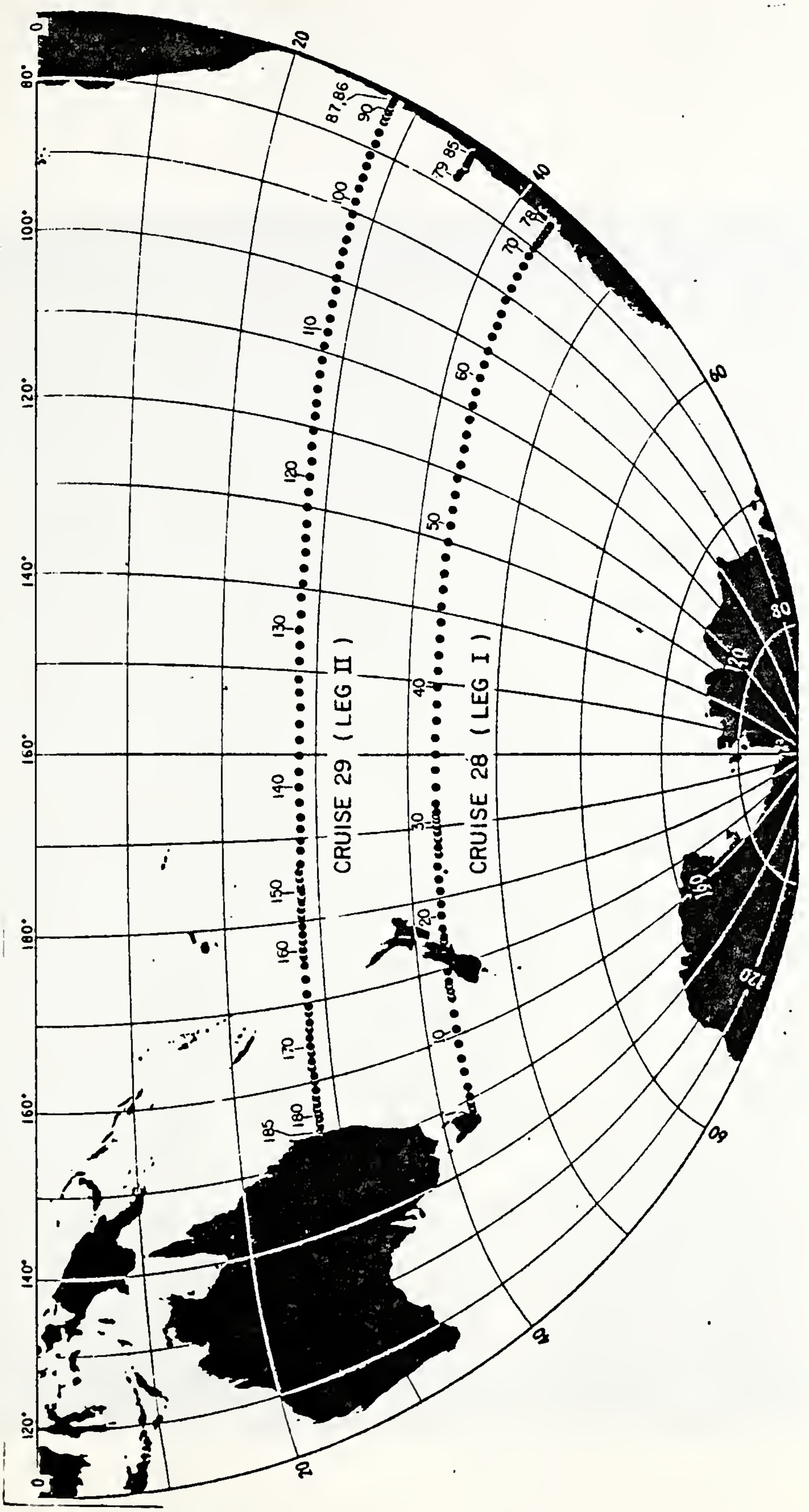

Figure 1. SCORPIO Transits along $28^{\circ}S$ and $43^{\circ}S$

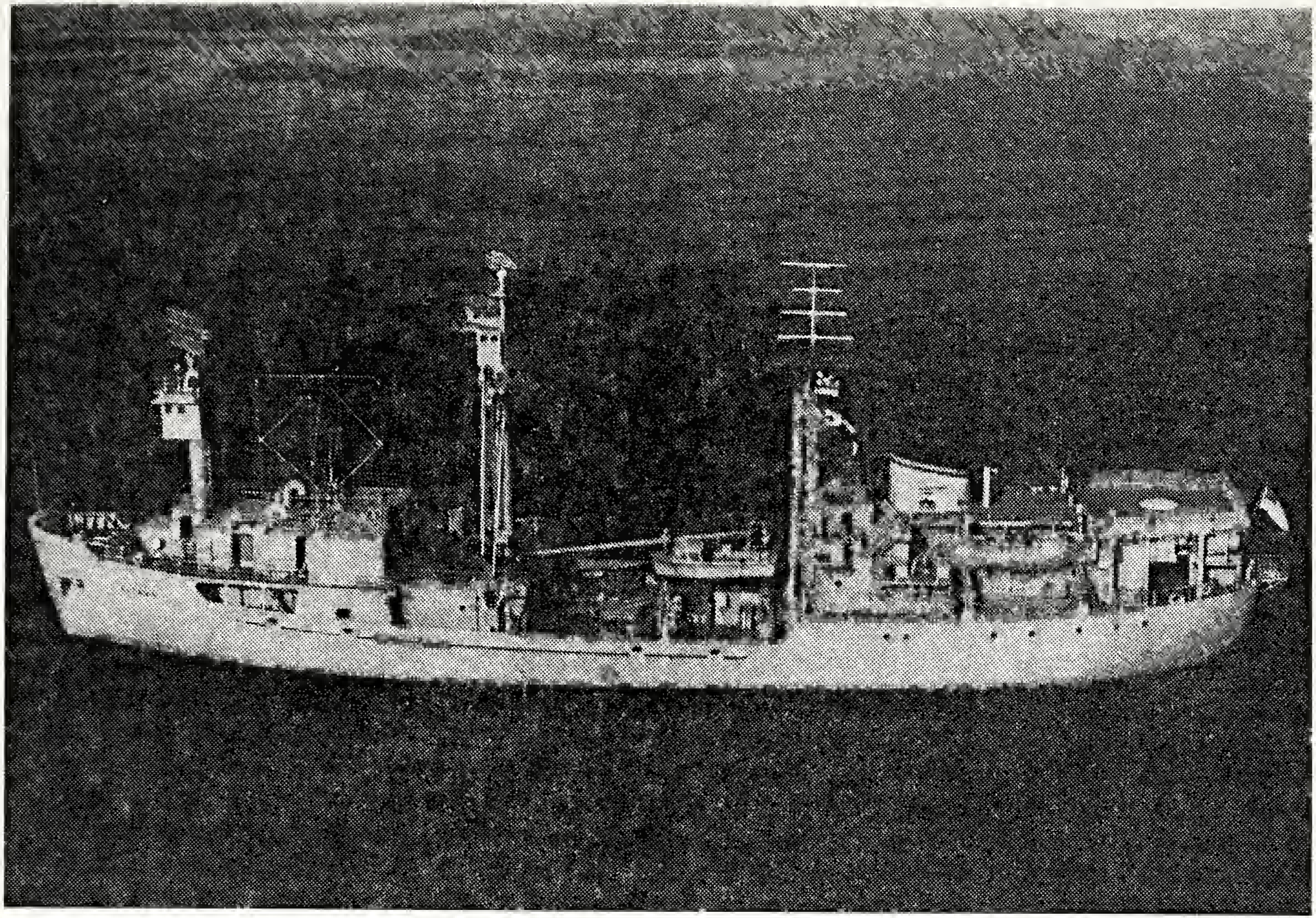

Figure 2. USNS ELTANIN

86, occupied on June 4, 1967 and its last station, number 185, on July 31, 1967. Since the data were collected in less than a five month period, it has been assumed they are simultaneous.

There are small voids in the cross-sectional latitudinal area where data were not taken. These voids existed primarily along the ocean bottom where the soundings did not reach, and also at the end points of the tracks between the end stations and the beach. The deepest sounding data were extended all the way to the sea floor directly under that station. The method used for extrapolating deep current velocities into these ocean bottom regions is described in detail later in this thesis, in Section IV B. Regarding the end points, the data of the end stations were extended horizontally until the beach slope terminated the extension. Appendix D contains the end point data. It is shown that these ends of the sections contribute negligible amounts to the mass, salt and heat transport totals.

B. COMPUTATION OF VELOCITIES, TRANSPORT OF MASS, SALT CONTENT AND HEAT

There have been limited synoptic velocity measurements made in the South Pacific. With the geostrophic equilibrium assumption, together with the procedure of Sverdrup et al. (1942), temperature and salinity data such as that of the SCORPIO Expedition may be utilized to determine dynamic height and synoptic velocity values for areas of interest. The majority of the calculations for this study were performed on

an IBM-360/67 computer utilizing a basic program developed by Greeson (1974). The Greeson program was modified by Mason (1978) to evaluate data voids along the sea floor as well as to attribute net mass, salt and heat transport between individual station pairs and/or along an entire track to particular identifiable water masses.

Greenson's program initially took temperature and salinity data at various depths and interpolated them to standard depths. Next sigma-t, the specific volume anomaly and specific volume were calculated for each standard depth. Then the equation

$$\bar{\delta} = \frac{\delta_Z + \delta_{(Z+\Delta Z)}}{2}$$

was used to compute an average specific volume anomaly for each pair of standard depths for each station. Note that $\bar{\delta}$ was the average specific volume anomaly, and δ_Z and $\delta_{(Z+\Delta Z)}$ were the specific volume anomalies at the standard depths of Z and $Z+\Delta Z$.

Following this, dynamic heights, D , were computed for each station. To do this, the dynamic height difference, ΔD , between the standard depths was calculated by

$$\Delta D = \bar{\delta}[Z - (Z+\Delta Z)] .$$

The dynamic height of each station was produced by a summation of the dynamic height differences

$$\Sigma_o \Delta D = D .$$

Next, the program calculated the distance, L , between stations. This distance varied with latitude and longitude. With the calculated station separation, the relative velocity between station pairs for each standard depth was computed using the Helland-Hansen formula. Given relative velocities, absolute geostrophic velocities were derived by identifying a level of no motion. This level of no motion was defined by absolute geostrophic velocities of zero.

Density was calculated using the formula:

$$\rho_{STP} = \frac{1}{\alpha_{STP}}$$

where α_{STP} is the specific volume for a particular salinity, temperature and pressure.

This process has produced what was described by Greeson (1974) as four corners of a rectangle limited by two oceanographic stations and two standard depths with four measurements of temperature, salinity, velocity and density. These four sets of measurements were distributed one to each corner of the rectangle and then the sets were averaged giving a composite value for the bounded area. This area was defined by the station separation and the standard depth internal. The mass transport for the subject vertical area was computed given the area density, velocity and area size. Next the calculated mass transport was multiplied by the average salinity and average absolute temperature. This resulted in an area salt flux and heat flux. Summing over the water column

produced the net mass, salt and heat flux for that pair of stations. The program then determined the net transport between each pair of standard depths, coast to coast, by summing the area values horizontally. A vertical summation process gave the total net mass, salt and heat transport for the entire latitudinal section.

The area extending from the deepest standard common depth to the bottom was handled in a slightly different manner. The vertical area between the sea floor and the deepest common depth between adjacent stations was first determined. Next it was assumed that the velocity of the sea floor was zero; therefore, the average of the deepest common level absolute geostrophic velocity and the zero sea floor velocity was applied as representative of this bottom area. Mass transport in this bottom area was calculated by multiplying this average velocity by the vertical area and deepest calculated density.

To arrive at salt and heat transport, the area mass transports were multiplied by the deepest recorded salinity and temperature which was assumed to extend on down to the sea floor.

An error may have been introduced in that, between a pair of stations, the bottom area water mass was attributed to the deepest type parcel of water actually sampled. In other words, if the deepest water sampled was an intermediate type of water, the void from the sample depth to the sea floor would be treated as intermediate water with all associated characteristics (i.e., density, current velocity, etc.).

The level of no motion was determined by setting a constant depth across the ocean unless interrupted by shoaling bathymetry, in which case the closest standard depth to the bottom was utilized for that station pair. This constant depth across the ocean was then moved vertically to locate a level of minimum net mass transport. Once this was established, the level was again moved up and down to determine a level of minimum net salt transport. At each of these two minimum levels, the heat transport was calculated. Zero mass and salt transport values were the desired objective, but these were only approximately obtained since the possible level of no motion values were taken no closer than at 1-meter intervals.

C. IDENTIFICATION OF WATER MASSES

One objective of this investigation was for it to be somewhat compatible with the studies of Jung (1955), Greeson (1974), Baker (1978) and Mason (1978). These studies use a general stratification pattern of Upper, Intermediate, and Deep/Bottom waters. An appropriate water mass classification scheme had to be located and adopted, either verbatim or in a modified form. The water mass schemes of Sverdrup _et al_. (1942), Deacon (1963) and Wyrtki (1966), as reported by Knox (1970), Defant (1961), Radzikjovskaya (1965), Stepanov (1965) and Muromtsev (1963) were examined and the scheme of Muromtsev was selected as being the most comprehensive for the Pacific, especially for the South Pacific. The Muromtsev scheme

allowed for 14 different South Pacific water masses to be defined with temperature, salinity and oxygen range limitation, although oxygen composition was not used by this author. Depth criteria for the different masses was also included. Figures 3, 4 and 5 illustrate Muromtsev's water mass areas.

Table I illustrates the various water masses selected from the Muromtsev scheme. After comparing the oceanographic station data to the water mass scheme, certain parcels of water between identified masses were still unclassified. The temperature and salinity ranges of Muromtsev were then expanded as necessary to classify these transition zones. Table I shows this tabulation which is also illustrated in Figures 6 and 7.

The surface water masses of the South Pacific were found between the surface and about 200 meters. They were formed by direct interaction with the atmosphere and were subject to seasonal variations in characteristics. Of the water masses they had the least uniformity and were also subject to continental runoff and precipitation. The surface water of the South Pacific was composed of six distinct water masses: Equatorial Surface Water, Southern Tropic Surface Water, Peru Surface Water, South-Central Subtropic Surface Water, Surface Water of South Temperate Latitude and Antarctic Surface Water.

The subsurface waters were found between about 150/200m and down to 600m in depth. They were formed in the zone of subtropical convergence and sinking of surface waters. Also

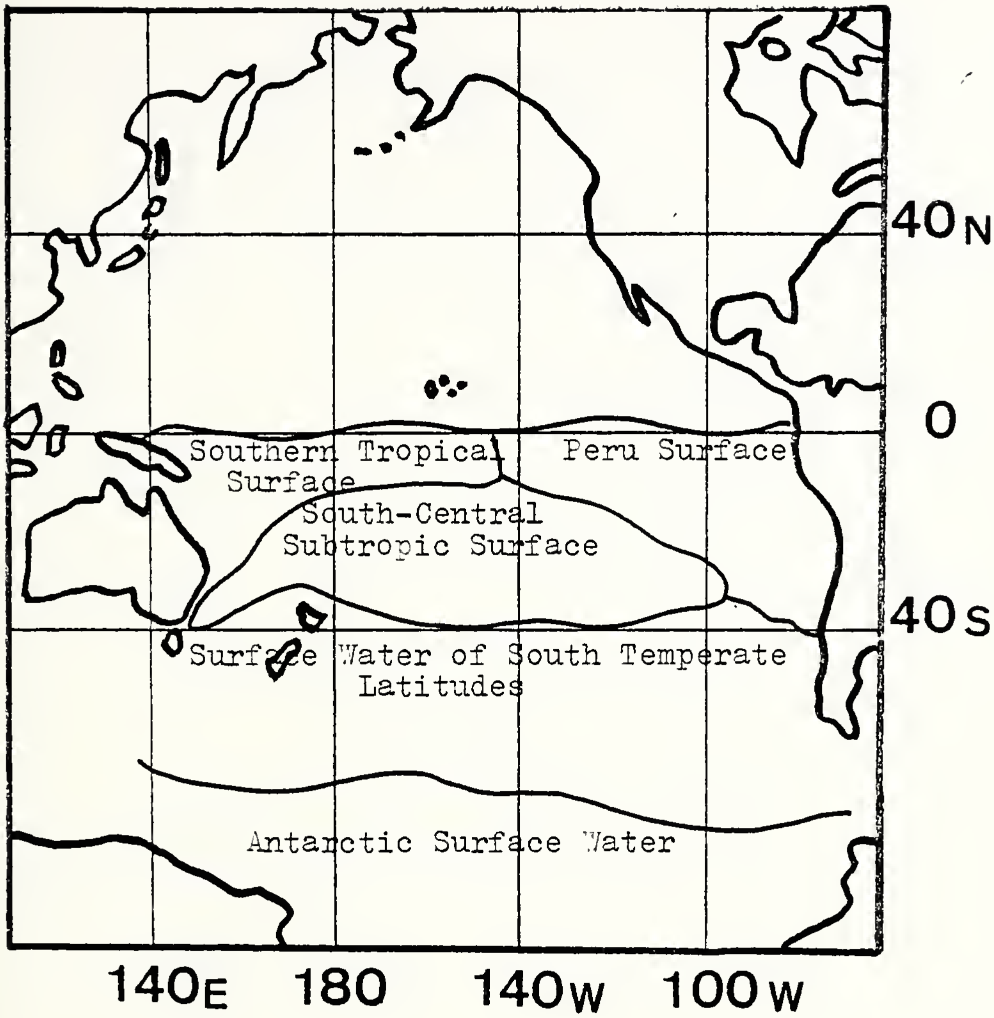

Figure 3. Muromtsev's Surface Water Mass Location

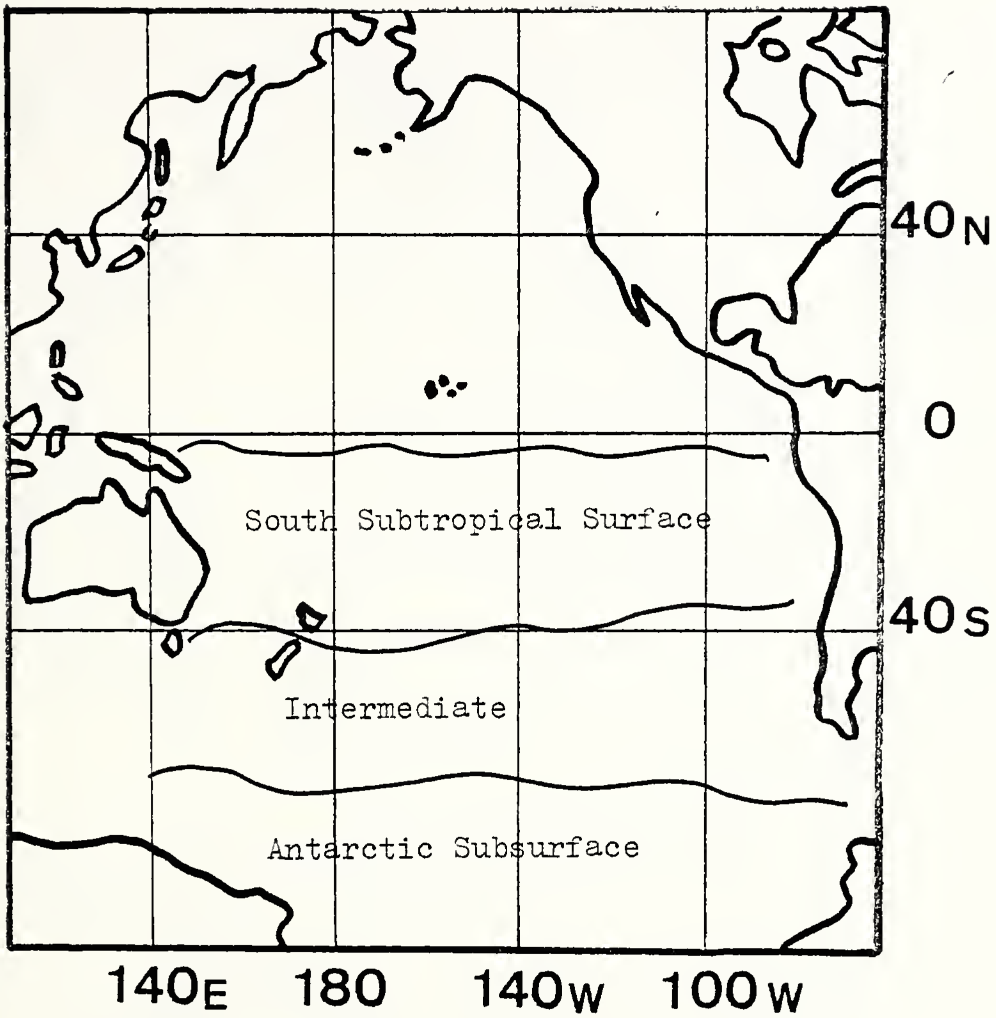

Figure 4. Muromtsev's Subsurface Water Mass Location

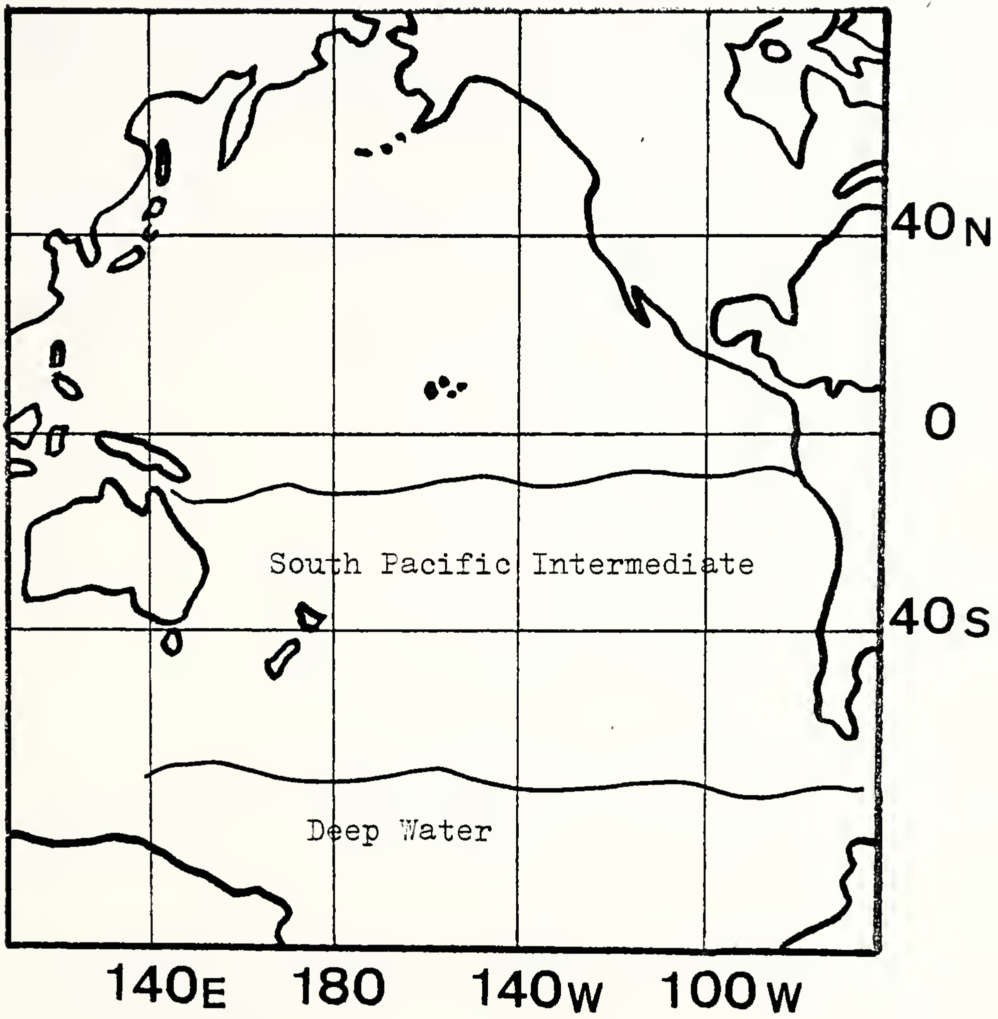

Figure 5. Muromtsev's Intermediate/Deep Water Mass Location

TABLE I. Muromtsev water mass parameters with modifications

	Water Mass	Tm^{o}	Ts^{o}	Sm%	Ss%	Depth
1.	Equatorial Surface Water	299.0-302.0		34.00-34.50		
2.	Southern Tropic Surface Water	298.0-302.0		35.00-35.50		
3.	Peru Surface Water	287.0-296.0		34.50-35.50	34.40-35.50	< 100m
4.	South-Central Subtropic Surface Water	293.0-298.0	292.4-298.0	35.50-36.45	35.50-36.50	< 150m
5.	Surface Water of South Temperate Latitudes	278.0-288.0		34.00-34.50	33.7-35.1	< 200m
6.	Antarctic Surface Water	271.0-275.0	271.2-275.0	33.50-34.00		
7.	South Subtropical Subsurface Water	283.0-293.0	281.5-293.1	34.80-36.30	34.30-36.30	< 650m
8.	Antarctic Subsurface Water	271.1-272.5		34.00-34.60		
9.	South Pacific Intermediate Water	276.0-279.0	275.6-281.5	34.10-34.50	34.10-34.68	> 200m < 2000m
10.	Equatorial Intermediate Water	277.5-279.5		34.55-34.65		> 150m < 1000m
11.	South Pacific Upper Deep Water	275.0-275.5	275.0-276.0	34.61-34.66	34.58-34.76	
12.	Underlying Deep Water	274.7-275.0	274.6-275.0	34.63-34.73	34.63-34.75	
13.	Antarctic Bottom Water	273.2-273.8	273.2-275.0	34.70-34.72		
14.	Pacific Bottom Water	274.0-274.6		34.64-34.71	34.64-34.80	

(m) Muromtsev (s) Sherfesee modifications

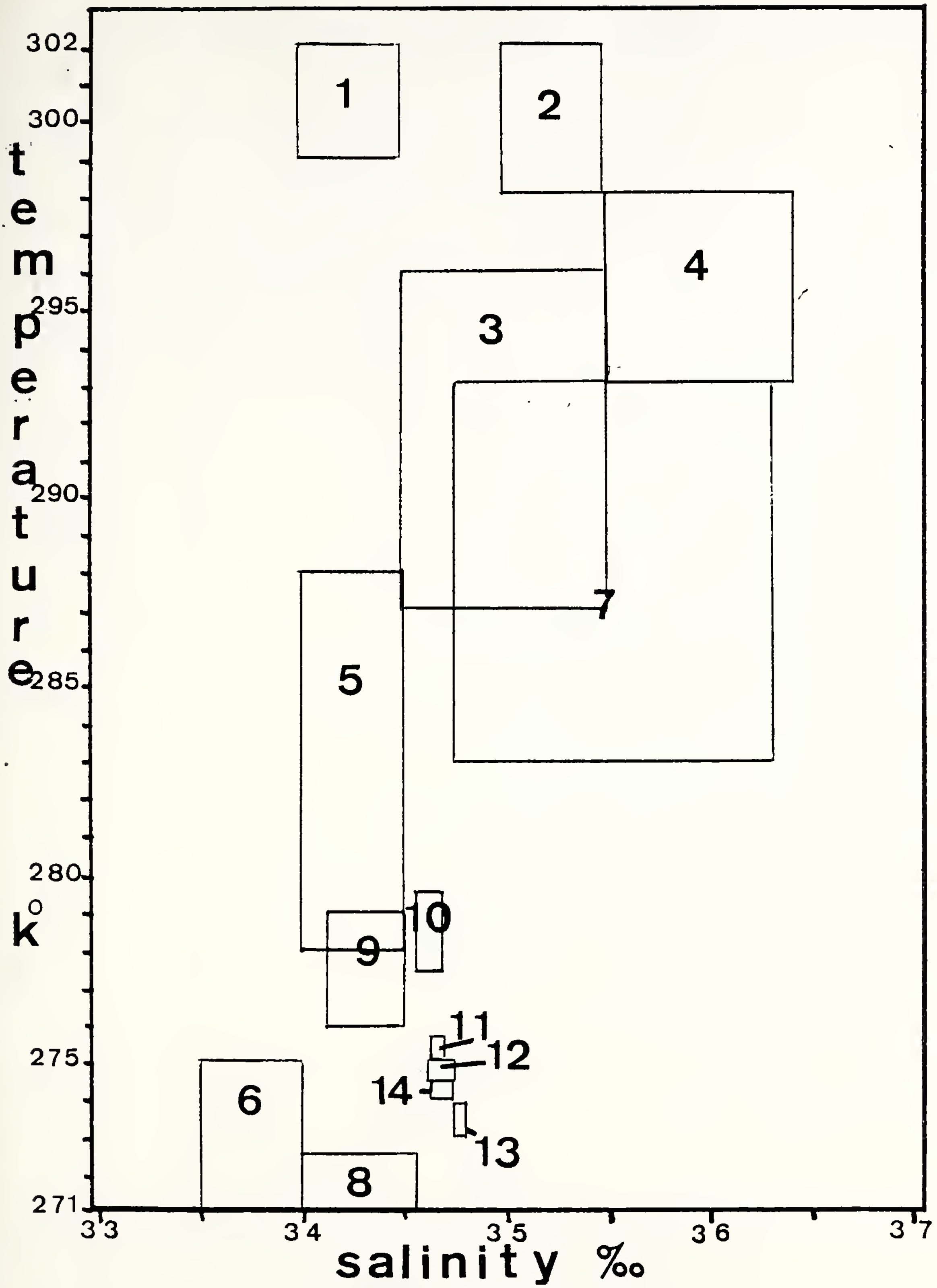

Figure 6. Temperature/Salinity Diagram for Muromtsev Water Mass Classification

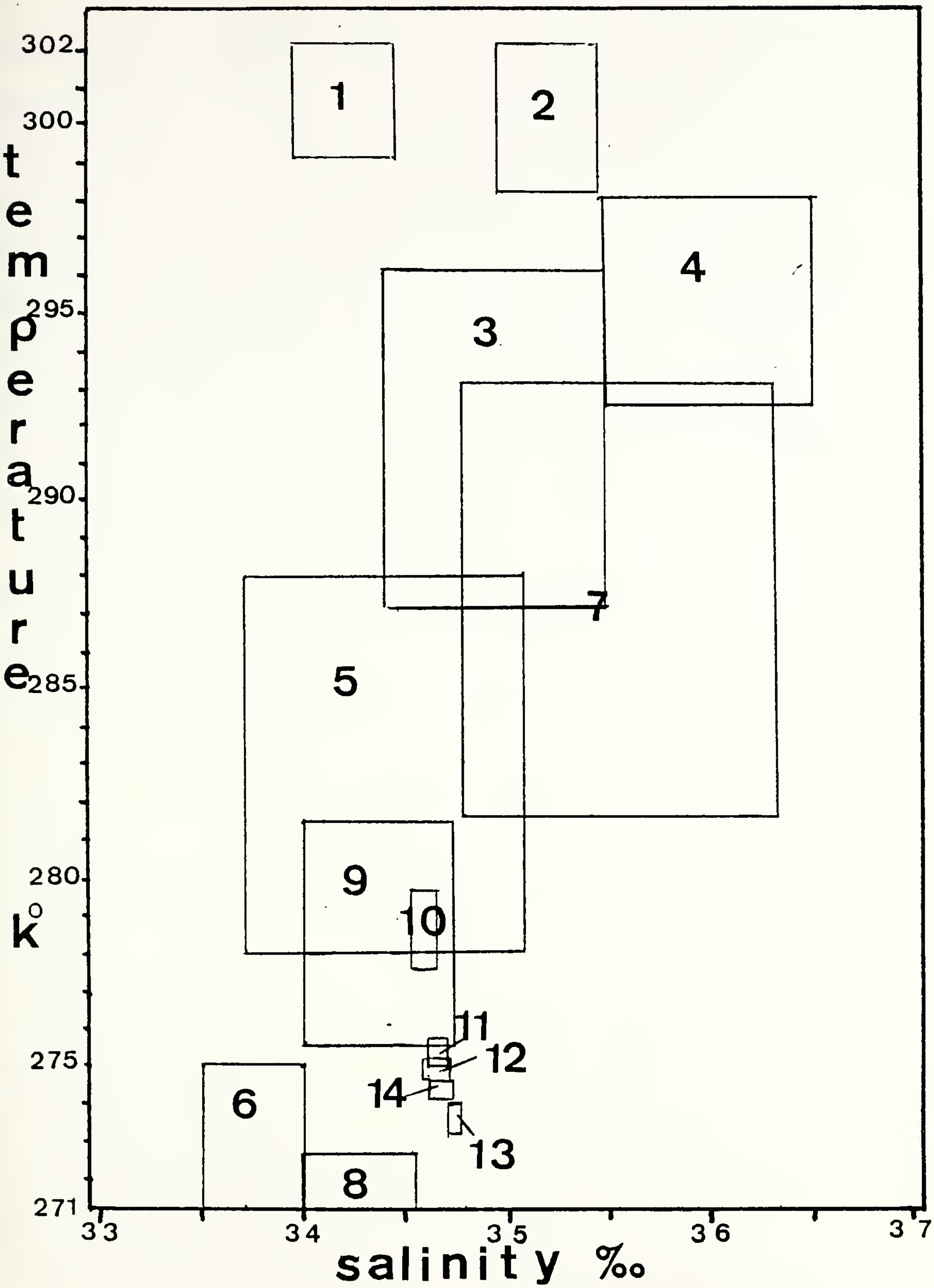

Figure 7. Temperature/Salinity Diagram for Modified Muromtsev Water Mass Classification

the influence of winter convection assisted in their formation. The subsurface waters had a higher degree of uniformity than the surface water. Muromtsev (1963) made the distinction between primary waters and secondary waters. Primary waters sank directly from the surface and were characterized by semiannual temperature and salinity fluctuations. Secondary waters were formed by the mixing of two or more types of surface water with no annual changes. Both the two subsurface water masses, South Subtropical Subsurface Water and Antarctic Subsurface Water, were considered primary waters.

The intermediate waters were located between about 400 and 1500m in depth and were formed in the zone of convergence and sinking of surface waters. They can also be formed by the mixing of two or more water types. Again this category could have both primary (slight annual variations) and secondary (no annual fluctuations) characteristics. The two intermediate water masses in the South Pacific were termed South Pacific Intermediate Water (primary) and Equatorial Intermediate Water (secondary).

Deep water was situated between roughly 1500m and 4500m in depth and was formed by the mixing of three or more water types. They were then secondary waters and had a high degree of uniformity. Two such water masses were classified for the South Pacific, the South Pacific Upper Deep Water and the Underlying Deep Water.

The last major type was the Bottom waters which were formed in the high southern latitudes. Two masses were

classified, the Antarctic Bottom Water and the Pacific Bottom Water. Muromtsev (1963) referred to both of these as secondary water masses.

The salinity, temperature and approximate depth characteristics of these 14 waters were compared with each block of water bounded by a pair of stations and adjacent standard depths. This classified over 99.5% of the parcels. Water with the defined temperature and salinity characteristics of Peru Surface Water was found on the surface in and around New Zealand. The author believes that this water is not the same water found off the coast of Peru, but is, in fact, formed in the Tasman Sea in a similar manner as in the formation of Peru Surface Water. This Pseudo Peru Surface Water has been for numerical calculations classified under Pseudo Peru Surface Water.

Figures 8 and 9 illustrate the water masses found along the two latitudinal cross sections.

D. THE CIRCULATION OF THE SOUTH PACIFIC

The surface circulation of the South Pacific Ocean consists of two large anticyclonic gyres. One is centered in the eastern South Pacific in the neighborhood of 30°S; the second gyre of smaller diameter is in the Tasman Sea between New Zealand and Australia. Cold low salinity water at the higher latitudes flows to the east as the Antarctic Circumpolar Current, and driven by strong northwesterly winds, moves to the eastern Pacific. There it is deflected to the north as the Peru Current, and also to the South Atlantic via

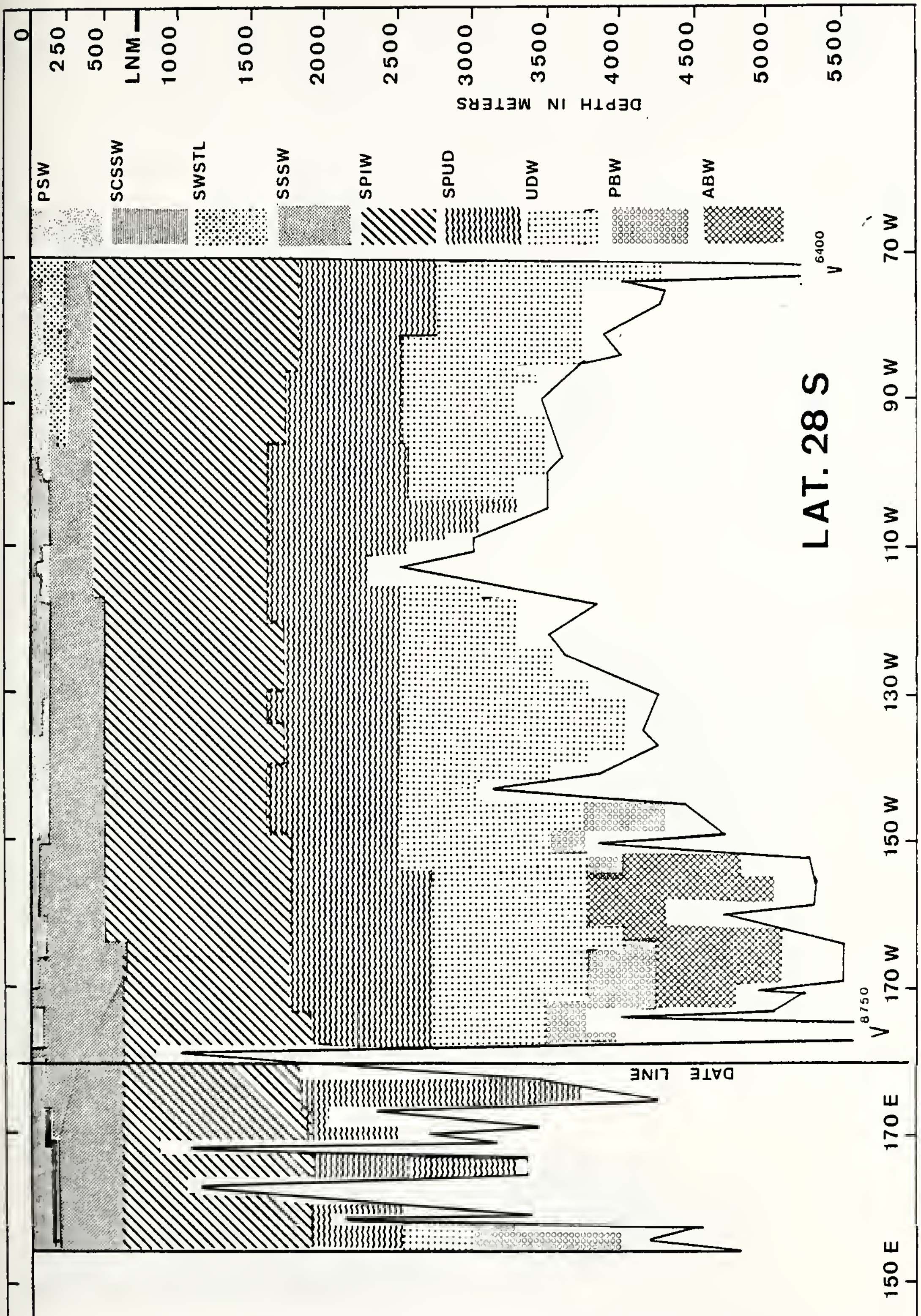

Figure 8. Cross Sectional Area along 28°S

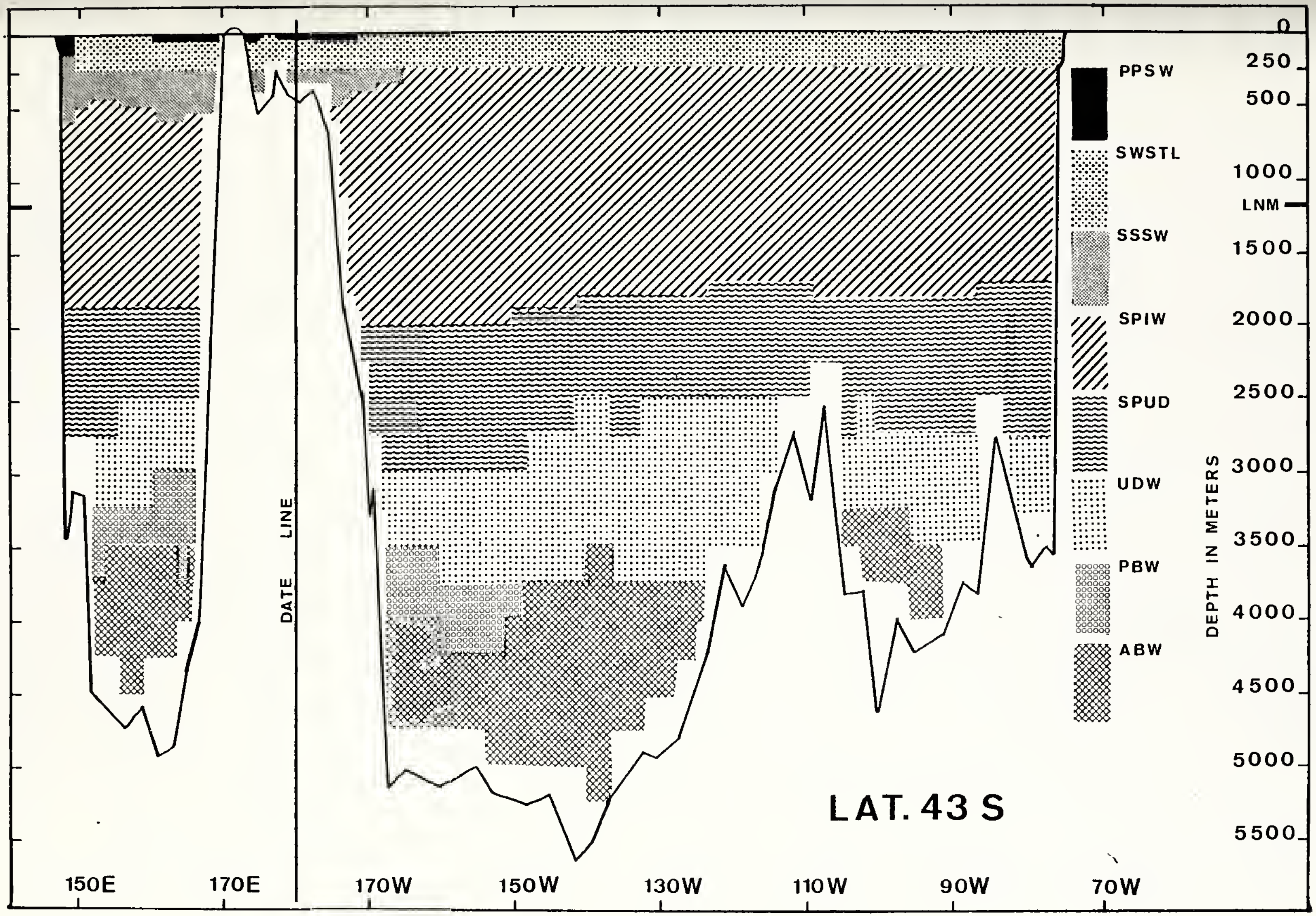

Figure 9. Cross Sectional Area along 43°S

the Drake passage. The Peru Current flows along the west coast of South America picking up subsurface water through upwelling as the Coriolis force deflects water to the left. The Peru Current, upon entering the tropics, turns west becoming the South Equatorial Current, where there is exchange with intertropical water. Eventually, the waters turn poleward along the east coast of New Zealand, and along the east coast of Australia as the East Australia Current. There is evidence that this anticyclonic gyre may extend to depths of 2000 meters (Reid, 1973).

In the Tasman Sea, water cycles in a counterclockwise (anticyclonic) path. It travels north along the west coast of New Zealand, then west to join the East Australia Current for its trip south where it links up with the Antarctic Circumpolar Current for an eastward journey.

Intermediate waters originate in the higher latitudes, between 45°S and 55°S, (Newmann and Pierson, 1966) which flow north in an anticyclonic cycle. Muromtsev (1963) wrote concerning the South Pacific intermediate water that its anticyclonic gyre is larger than that of the surface water as it starts at 60°S and crosses the Equator where it involves North Pacific intermediate water. The combined intermediate waters spread out through the entire ocean.

Below the intermediate water is the deep water, composed of Pacific Ocean water and deep Indian Ocean water of high salinity entering south of Australia.

This wide deep current moves north with some water ascending at the equator and returning south, while the remainder may move all the way north to the Aleutians before ascending and returning south. This southward spreading of Deep Water in the South Pacific was supported by Deacon (1927), while Neumann and Pierson (1966) attributed to Sverdrup _et al_. (1942) the statement of a Pacific deep water exchange between the two hemispheres, with a northern current to the west and southern current to the east.

The deepest water is the bottom water which forms in the high southern latitudes by sinking cold surface and subsurface waters along the continental slope of Antarctica. Perry and Walker (1977) state that the Weddell Sea is the primary production area of Antarctic Bottom Water which is the lowermost mass of water in the Indian, Atlantic and Pacific Oceans, extending well north of the equator.

The circulation between the surface and about 2000 meters in the South Pacific is anticyclonic. There is some evidence (Warren, 1973) and at least one theory (Stommel, 1958) that the circulation below 2000 meters and extending to the sea floor is cyclonic (Figure 10).

To paraphrase Muromtsev (1963), the overall plan of circulation of Pacific water shows that the principal source from which the waters of this ocean are derived is located in the high southern latitudes. From here the water spreads at all depths through the southern part of the ocean and enters the northern part by deep and bottom currents. Here the

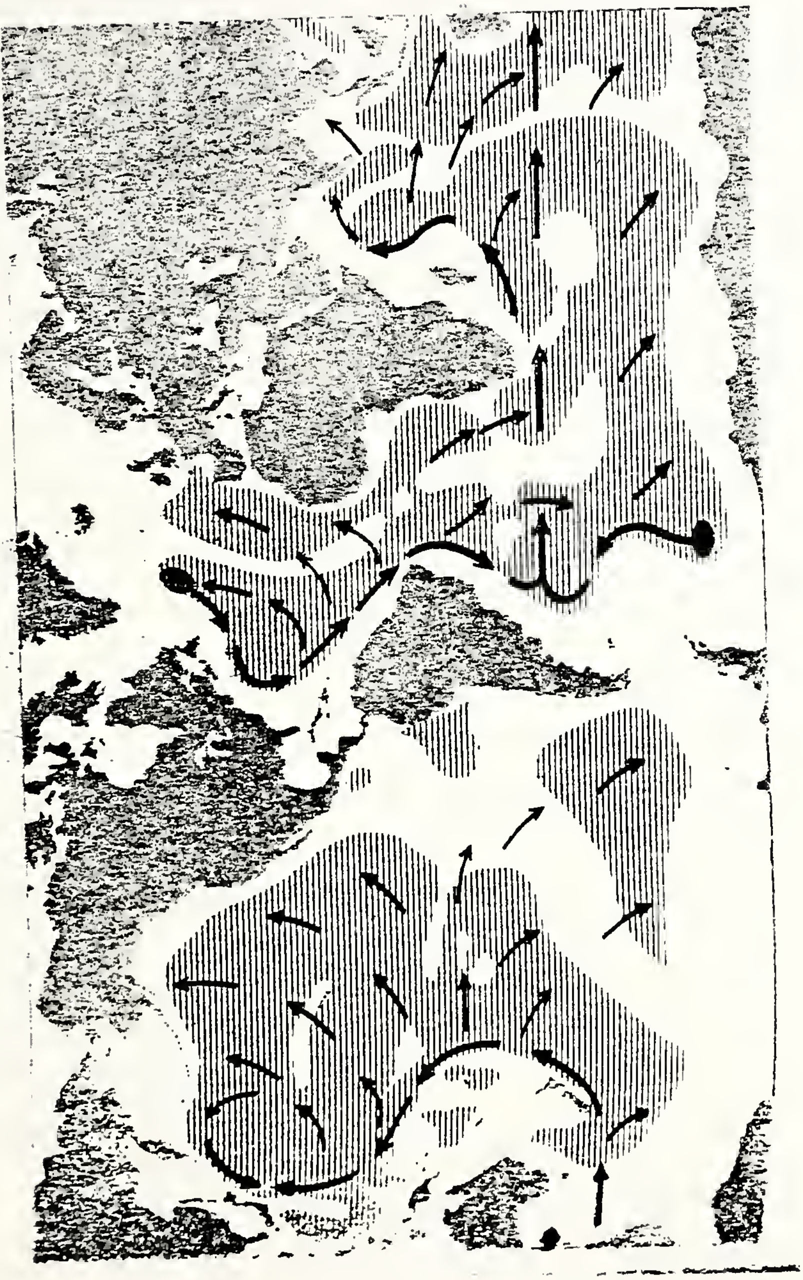

Figure 10. Bottom Water Circulation Theory

deep water, along with the overlying intermediate and subsurface waters, wells up and forms the top water, while surface water sinks into deep southward flowing upper/deep currents. Eventually this water exits the Pacific via the Drake Passage to the South Atlantic.

E. DETERMINATION OF UPPER, INTERMEDIATE AND DEEP/BOTTOM WATER CIRCULATION

As discussed in the previous section, the 14 South Pacific Ocean water masses described by Muromtsev (1963) were compared against the station measurements. This resulted in ten water masses being identified. Next the mass, salt and heat transports were determined within each station pair for each water parcel. Then the transports were attributed to each of the ten water masses plus an unknown mass. That unknown water mass, different from the Pseudo Peru Surface Water, was usually a coastal surface sample with slightly lower salinity than defined, and in any event, it was a negligible quantity.

The ten water masses identified were:

Peru Surface Water
Pseudo Peru Surface Water
South Central Subtropic Surface Water
Surface Water of South Temperate Latitudes
South Subtropical Subsurface Water
South Pacific Intermediate Water
South Pacific Upper Deep Water
Underlying Deep Water
Antarctic Bottom Water
Pacific Bottom Water

In determining a net transport, a negative sign indicates southward transport, while a positive sign indicates northward transport. Once the net transport for each water mass of each station pair was calculated, these values were summed, resulting

in an overall coast-to-coast net transport of mass, salt and heat by water mass type.

In order to be compatible with Jung (1955), Baker (1978) and Mason (1978), the ten water masses were grouped into Upper, Intermediate and Deep/Bottom categories. As will be seen later, for the South Pacific Ocean, this may not be the most appropriate scheme.

The Upper category was composed of Peru Surface Water, South Central Subtropic Surface Water, Surface Water of South Temperate Latitudes, South Subtropical Subsurface Water, the Pseudo Peru Surface Water and Unknown Water.

The intermediate layer was composed solely of South Pacific Intermediate Water; and the Deep/Bottom level was made up of South Pacific Upper Deep Water, Underlying Deep Water, Antarctic Bottom Water and Pacific Bottom Water.

An attempt was then made to examine general circulation information available based on only two zonal tracks separated by approximately 15° of latitude. One procedure here, which was unsuccessful, was to plot the absolute velocity both in a vertical cross section and on a horizontal plan view.

Current velocities at certain selected levels (0, 100, 250, 500, 1000, 2000, 2500, 3000, 3500, 4000 and 5000 meters) were calculated. These were geostrophic velocities between station pairs calculated at the selected depths. These depths were chosen as they essentially covered the depth of the water column and represented portions of each identified water mass. The tabulated data will be found in Appendix C.

Another attempt to determine the general circulation pattern was based on the net mass transport values between stations in each of the three (Upper, Intermediate, and Deep/Bottom) layers. Appendix B has the tabulated net mass transport data for each layer, with subdivisions by water mass.

The circulation pattern composed of station pairs along each track consisted of a series of opposing north/south flows of various magnitudes. The eddy circulation was apparent in the pattern made up of selected geostrophic velocities as well as in net mass transports. Even with station pairs approximately two degrees of longitudinal distance apart, opposing flows [as were found also by Warren (1973)] from one pair to the next occurred. These opposing flows are probably associated with mesoscale eddies.

V. DISCUSSION OF RESULTS

A. THE LEVEL OF NO MOTION

The objective of this study was to determine a constant depth motionless level across the entire Pacific. This objective differed from the level of no motion determination method of Baker (1978) in which each level between station pairs was selected individually in an attempt to achieve a net mass and salt balance. Near the ends of each latitude section the motionless layer was selected at the ocean floor. Tables II and III illustrate the net transports at various levels. The trans-oceanic levels for 28°S and 43°S are illustrated in Figures 8 and 9 respectively. The chosen levels of no motion were approximately 762m (28°S) and 1203m (43°S) and were the dominant levels used, Tables IV and V.

B. MASS AND SALT TRANSPORT

As was stated earlier, the criterion of approximately zero mass transport was considered to be the primary factor for continuity. Zero net salt transport was of secondary importance. As shown in Tables II and III, very small values of mass and salt were obtained at different depths very close to each other. The level which gave the smallest net mass transport across 28°S was 762 meters, which was selected as the level of no motion for the section. Across 43°S, the

TABLE II

LEVEL OF NO MOTION 28°S

DEPTH OF LEVEL OF NO MOTION	NET MASS TRANSPORT (10^{12} gm/sec)	NET SALT TRANSPORT (10^{12} °/oo/sec)	NET HEAT TRANSPORT (10^{12} cal/sec)
700	-3.8738	-131.708	-1034.07
750	-0.7893	- 24.9648	- 181.296
760	-0.1488	- 2.8013	- 4.2565
761	-0.0831	- 0.5269*	13.8967
762	-0.0166*	1.7732	32.5682
763	0.0447	3.8953	49.2305
764	0.1090	6.1189	66.9985
770	0.5032	19.7583	175.920
780	1.1329	41.5422	350.021
790	1.7586	63.1833	523.032

*Minimum net value

TABLE III

LEVEL OF NO MOTION 43°S

DEPTH OF LEVEL OF NO MOTION	NET MASS TRANSPORT (10^{12} gm/sec)	NET SALT TRANSPORT (10^{12} $^{\circ}/_{oo}$/sec)	NET HEAT TRANSPORT (10^{12} cal/sec)
1050	-12.7767	-444.146	-3478.68
1150	- 4.0488	-142.408	-1069.35
1180	- 1.7864	- 64.2029	- 443.930
1200	- 0.1418	- 7.3359	12.0479
1202	- 0.0004*	- 2.4490	51.0940
1203	0.0800	- 0.0301*	70.3159
1204	0.1408	2.4334	90.1206
1206	0.2812	7.2849	128.897
1208	0.4214	12.1323	167.628
1210	0.5613	16.9695	206.275
1212	0.7003	21.7734	244.668
1220	1.2492	40.7502	396.283
1250	4.809	164.078	1390.62
1280	6.6521	227.805	1899.19
1301	7.8318	268.624	2224.56

*Minimum net value

TABLE IV

LEVELS OF NO MOTION USE %

28° South Pacific (99 pairs of stations)

Level of No Motion	No. of Times Used/Section	% Total Station Pairs
100	2	2.0%
762	97	98.0%
	99	100%

TABLE V

LEVELS OF NO MOTION USE %

43° South Pacific (77 pairs of stations)

Level of No Motion	No. of Times Used/Section	% Total Station Pairs
250	2	2.6%
300	1	1.3%
350	3	3.9%
400	3	3.9%
450	2	2.6%
650	1	1.3%
1100	1	1.3%
1203	64	83.1%
	77	100%

effects of net salt transport entered into choice of the level of no motion at 1203 meters, selected as the level best for minimizing both mass and salt transport. This author doubts that stating the levels to be 762 and 1203 meters is without some error. As can be seen by the tabulated results of Tables II and III, the calculated balance is very sensitive to changes in levels of no motion. It is doubtful that even the accuracy of the initial depth, salinity and temperature measurements, although very acceptable in their own right, justify the precise levels offered. The level of no motion should in reality be considered in the neighborhood of these depths.

The net mass transport across the 28°S and 43°S latitudinal sections associated with the selected levels of no motion was -0.02 and 0.08 times 10^{12} gm/sec with the net salt transport of 1.8 and -0.03 times 10^{12} °/oo/sec as shown in Tables VI and VII.

C. HEAT TRANSPORT

Latitudinal net meridional transport of heat may be expressed as

$$C_{ps}(T_n - T_s)\ \rho_s\ V_{ns}\ .$$

If the specific heat at constant pressure of sea water, C_{ps} , is assumed to be one (cal/g °C), the above expression reduces to

$$(T_n - T_s)\ \rho_s\ V_{ns}\ .$$

TABLE VI

TOTAL NET TRANSPORT

28°S Pacific Ocean

Water Mass	Mass Transport	Salt	Heat
Peru Surface Water	2.16	75.17	628.53
Pseudo Peru Surface Water	-0.14	-5.06	-41.83
South Central Subtropic Surface Water	-1.10	-38.72	-328.21
Surface Water of South Temperate Latitudes	0.18	5.46	52.39
South Subtropical Subsurface Water	2.87	100.73	826.45
Unknown	0.62	21.19	178.74
South Pacific Intermediate Water	-3.45	-118.88	-945.01
South Pacific Upper Deep Water	-17.44	-604.15	-4800.14
Underlying Deep Water	-5.42	-187.73	-1489.94
Pacific Bottom Water	10.51	388.62	3068.35
Antarctic Bottom Water	11.19	365.17	2883.24
Net	-0.02	1.8	32.57
	(10^{12} gm/sec)	(10^{12} °/oo/sec)	(10^{12} cal/sec)

TABLE VII

TOTAL NET TRANSPORT

43°S Pacific Ocean

Water Mass	Mass Transport	Salt	Heat
Peru Surface Water	0.0	0.0	0.0
Pseudo Peru Surface Water	0.37	13.00	105.52
South Central Subtropic Surface Water	0.0	0.0	0.0
Surface Water of South Temperate Latitudes	2.20	75.10	619.15
South Subtropical Subsurface Water	0.59	21.15	170.20
Unknown	-0.02	-0.79	-6.75
South Pacific Intermediate Water	7.78	267.01	2166.92
South Pacific Upper Deep Water	-6.83	-236.74	-1880.73
Underlying Deep Water	-9.13	-316.75	-2509.00
Pacific Bottom Water	2.65	92.11	727.47
Antarctic Bottom Water	2.47	85.88	677.54
Net	0.08	-0.03	70.32
	(10^{12} gm/sec)	(10^{12} °/oo/sec)	(10^{12} cal/sec)

The meridional mass transport is $\rho_s V_{ns}$ and T_n is the northward moving water temperature, T_s (°C) the southward moving water temperature. Mass continuity requires the mass transport $\rho_s V_{ns}$ (north) and $\rho_s V_{ns}$ (south) to cancel each other for a mass balance to be present across the section. This is not necessarily the case for heat transport as was evident by the results. The temperatures of the water being transported across the section differ, thereby producing the net meridional transport. Measurement of that heat flux was a prime objective of this study. Of the two latitudinal sections, the more poleward section, at 43°S, will be discussed first. Ten separate water masses were identified and their respective net heat transports calculated (Table VIII). Peru Surface Water accounted for a net northward transport of heat. Pseudo Peru Surface Water in the western Pacific had a net southern heat flow. Surface Water of the South Temperate Latitudes had a net northward flow of heat. There was also a net northward heat transport attributed to the South Subtropical Surface Water. The unknown surface water quantity had a small net heat transport to the south. Summarizing these separate surface or near surface water masses resulted in a net northward flow in the Upper level of approximately 888 x 10^{12} cal/sec.

The Intermediate level consisted solely of South Pacific Intermediate water which had a net northward transport of 2166 x 10^{12} cal/sec.

There were two deep water masses identified: South

TABLE VIII

NET HEAT TRANSPORT

Water Mass	28° S	43° S
Peru Surface Water	628.5	0.0
Pseudo Peru Surface Water	-41.8	105.5
South Central Subtropic Surface Water	-328.2	0.0
Surface Water of the South Temperate Latitudes	52.5	619.2
South Subtropic Subsurface Water	826.6	170.1
Unknown	178.7	-6.8
South Pacific Intermediate Water	-945.0	2166.9
South Pacific Upper Deep Water	-4800.0	-1880.7
Underlying Deep Water	-1489.9	-2509.0
Pacific Bottom Water	3068.4	727.4
Antarctic Bottom Water	2883.2	677.4
	33.0	70.0

Units are 10^{12} cal/sec

Pacific Upper Deep Water and Underlying Deep Water. These two deep water masses had a combined southward net transport of approximately 4390 x 10^{12} cal/sec. The bottom waters, Antarctic Bottom Water and Pacific Bottom Water transported heat to the north with a combined net transport of 1405 x 10^{12} cal/sec. When the deep and bottom net heat transports were combined, the resultant net was a southward flow of 2985 x 10^{12} cal/sec.

Along the more equatorward section of 28°S there were some general consistencies with the results of 43°S section and also some differences. Again the Peru Surface Water had a net northward transport while the Pseudo Peru Surface Water had a southward transport. A new water mass, the South Central Subtropic Surface Water, was identified and found to have a net southward transport. Surface Water of South Temperate Latitudes again had a northward transport, along with the South Subtropical Surface Water and the minor amount of unknown surface water. The combined total was calculated to be a net northward flow of 1316 x 10^{12} cal/sec.

As with the poleward section, the sole water mass found in the Intermediate level was South Pacific Intermediate Water. At this latitude it had a net southward transport of 945 x 10^{12} cal/sec rather than a northward transport as was the case at 43°S.

The Deep and Bottom waters (South Pacific Upper Deep Water, Underlying Deep Water, Pacific Bottom Water and Antarctic Bottom Water) had a much larger amount of net heat transported per water mass or even totaled as Deep Water (net southward

flow of 6290 x 10^{12} cal/sec) and Bottom Water (net northward transport of 5952 x 10^{12} cal/sec). However when combined into the Deep and Bottom level, the net transport was 338 x 10^{12} cal/sec to the south.

A comparison of the Upper, Intermediate and Deep/Bottom net transports of the two latitudes is as shown in Table IX.

TABLE IX

LAYER HEAT TRANSPORTS

LEVEL	28°S	43°S
Upper	1316	888
Middle	-945	2167
Deep/Bottom	-338	-2985
	33 x 10^{12} cal/sec	70 x 10^{12} cal/sec

There is larger net northward flow (70 x 10^{12} cal/sec) along 43°S than along 28°S (32 x 10^{12} cal/sec). However the attempt to combine the effects of various water masses causes their respective effects to be smoothed over. Table VIII which shows the net heat transport of each individual water mass is much more informative.

It is evident from Table VIII that the net water mass transport directions appear reasonable when associated with their respective water masses (i.e. Peru Surface Water and Pacific Bottom Water, north; Underlying Deep Water, south). The net northward transport of heat is the surprising factor.

A change of only 1 or 2% of the heat attributed to deep and bottom transport could easily have negated this northward transport. When one considers the initial assumptions upon which this study is based, this slight northward transport value is probably within the range of error for this study.

D. OCEANIC EDDY CIRCULATION

The calculated transport components suggest the presence of oceanic eddies. Appendix C illustrates the reverse pattern of point depth geostrophic velocities both vertically within a station pair and horizontally from one station pair to another.

Along the east coast of Australia, Harmon (1970) wrote that surface currents are complex, variable and strong. Water is transported south by large anticyclonic eddies, some of which may be 250km in diameter. These eddies may be formed when the main East Australia current bulges to the south and becomes unstable, causing the bulge to separate as an eddy. Along both transits near the coast of Australia eddies were apparent.

One example is offered here. Figure 11 illustrates the surface circulation around New Zealand. Attention is directed to the anticyclonic eddy off the eastern coast which was studied by Burns (1972). The coastal currents are derived from Stanton (1972). The geostrophic current directions are in approximate agreement with those of Burns and Stanton.

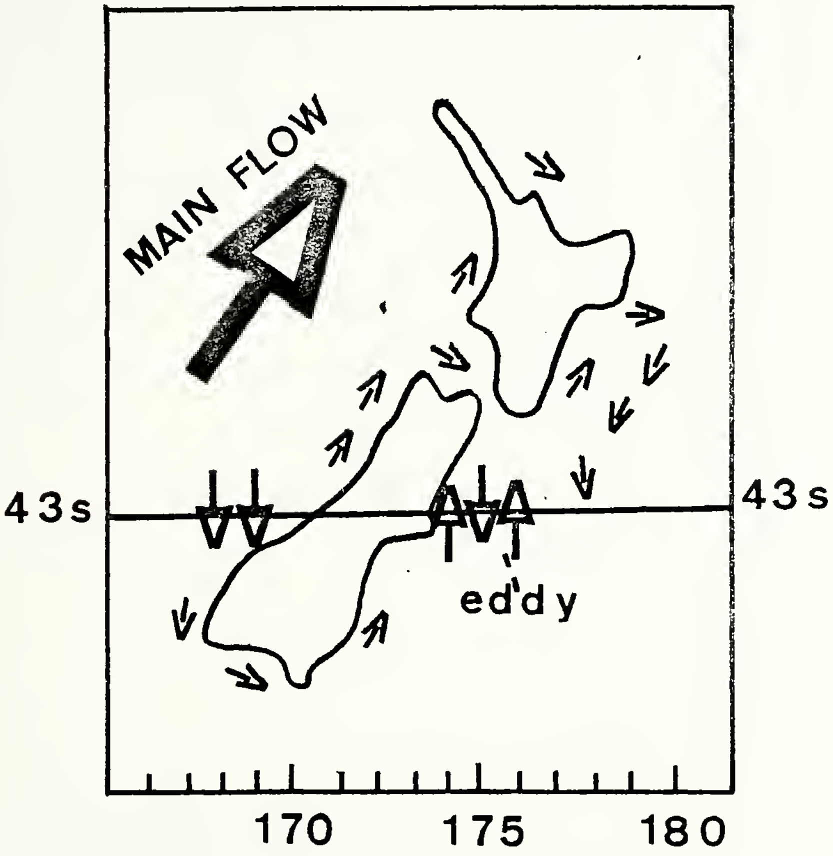

Figure 11. New Zealand Surface Circulation with Eddy

E. CALCULATED CIRCULATION PATTERN

The calculated circulation pattern is derived from mass transports and geostrophic current velocities. Fine scale interpretation was made using individual station-pair rates of mass transport along with geostrophic current velocities. Because of numerous direction and magnitude fluctuations between station pairs, the station pairs were first combined in 20° longitude segments. This proved to be too large a grouping scale as too many details were averaged out. Therefore 5° longitude segments were tried and found to be more ideal as pictured in Figures 12, 13, 14 and 15. The net flow of the deep waters (South Pacific Upper Deep Water and Pacific Bottom Water) was found to be southward while the Bottom Waters (Pacific Bottom Water and Antarctic Bottom Water) were found to have a net flow to the north. For this reason of opposing flow, the Deep/Bottom layer utilized by Jung (1955) and Baker (1978) has been subdivided into Deep layer and Bottom layer. The circulation layers are therefore termed Upper Layer, Intermediate Layer, Deep Layer and Bottom Layer.

1. Upper Circulation

The Upper Layer transport (Figure 16) was found to be anticyclonic with a large anticyclonic gyre between the coast of South America and about the International Date Line. A smaller anticyclonic gyre was also apparent to the west in the Tasman/Coral Sea area. Along the South American Coast, a southward flowing current was detected. The sampling was done in late May and early June in this area; it is proposed

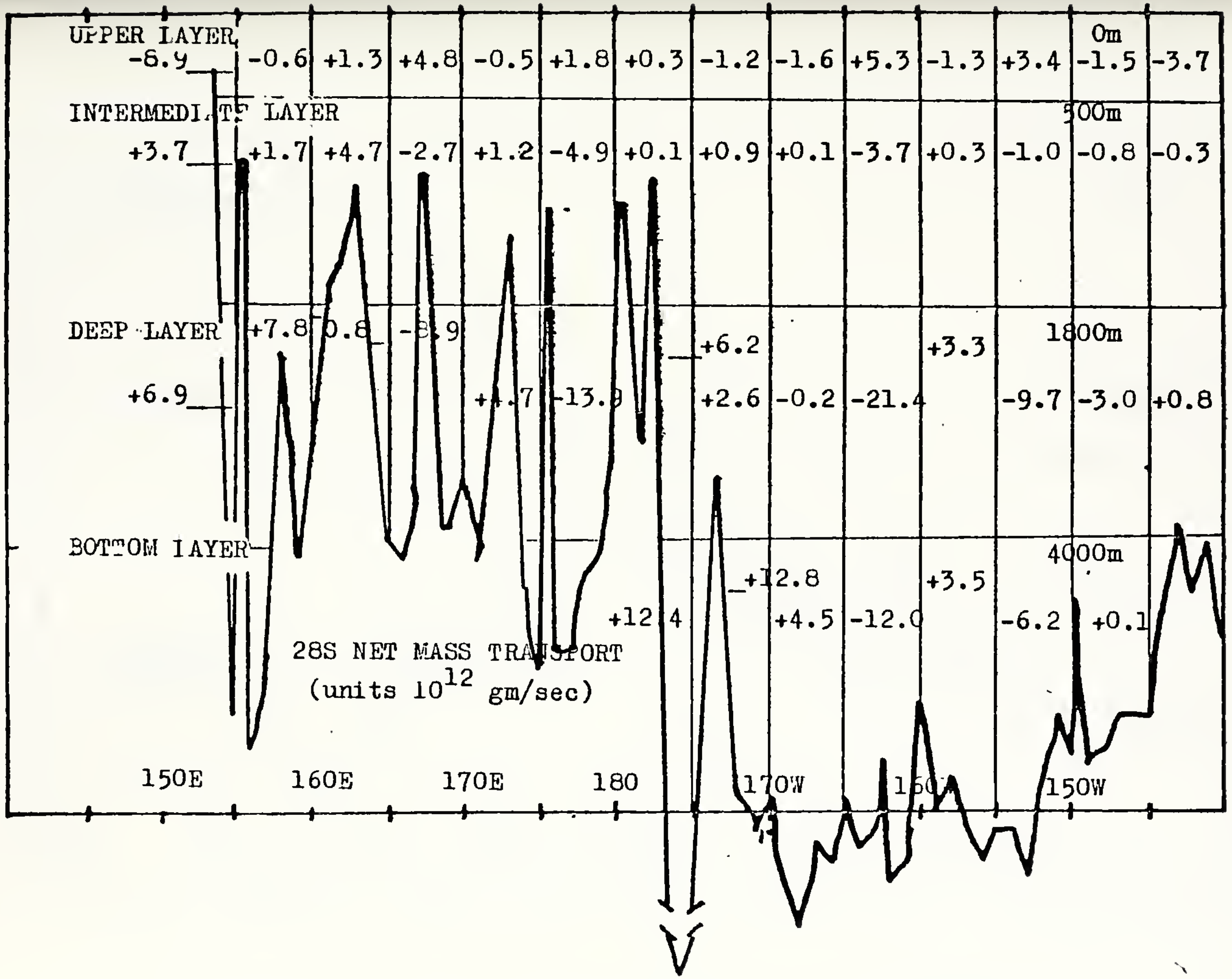

Figure 12. Mass Transport 28°S (West Section)

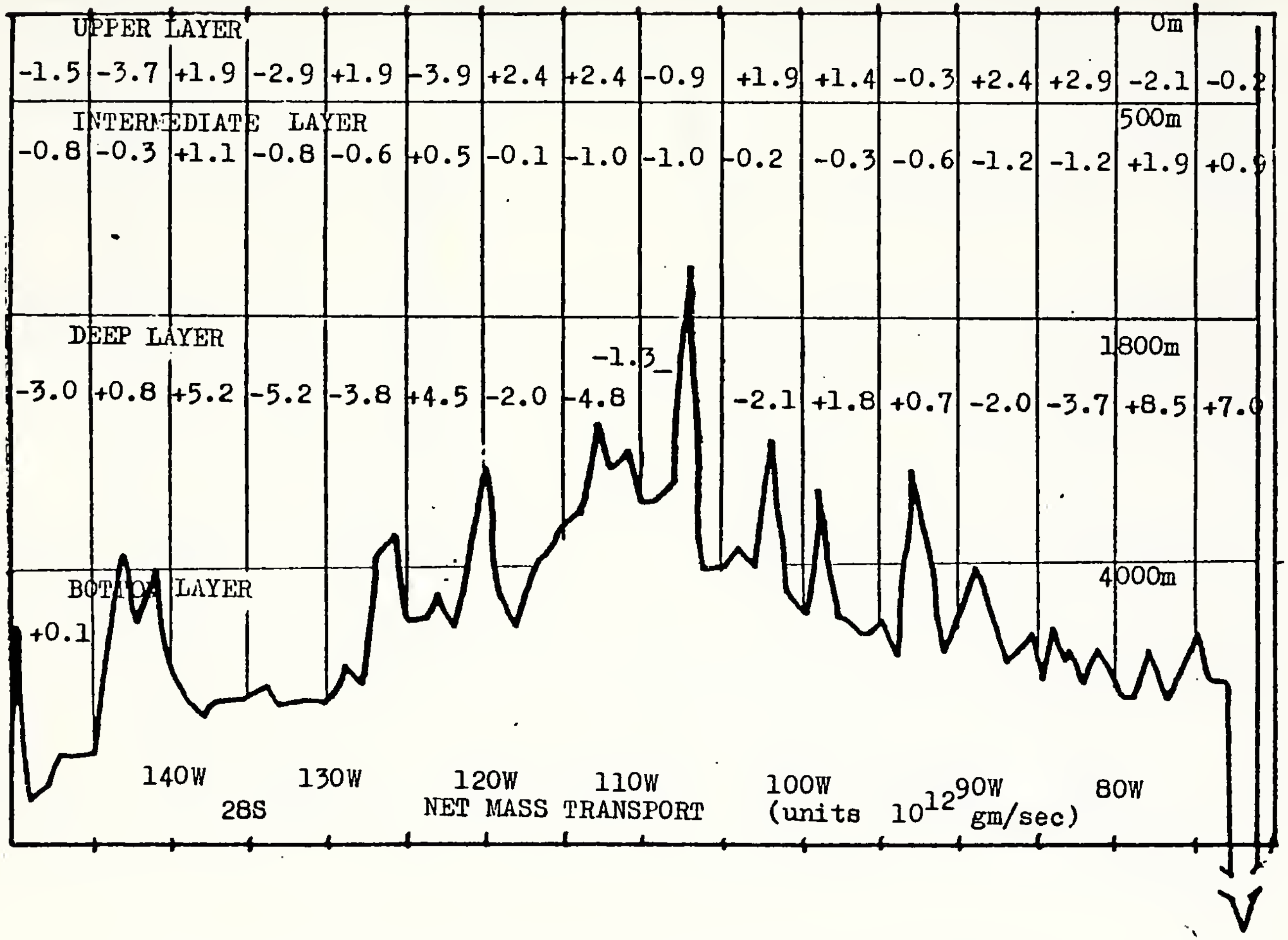

Figure 13. Mass Transport 28°S (East Section)

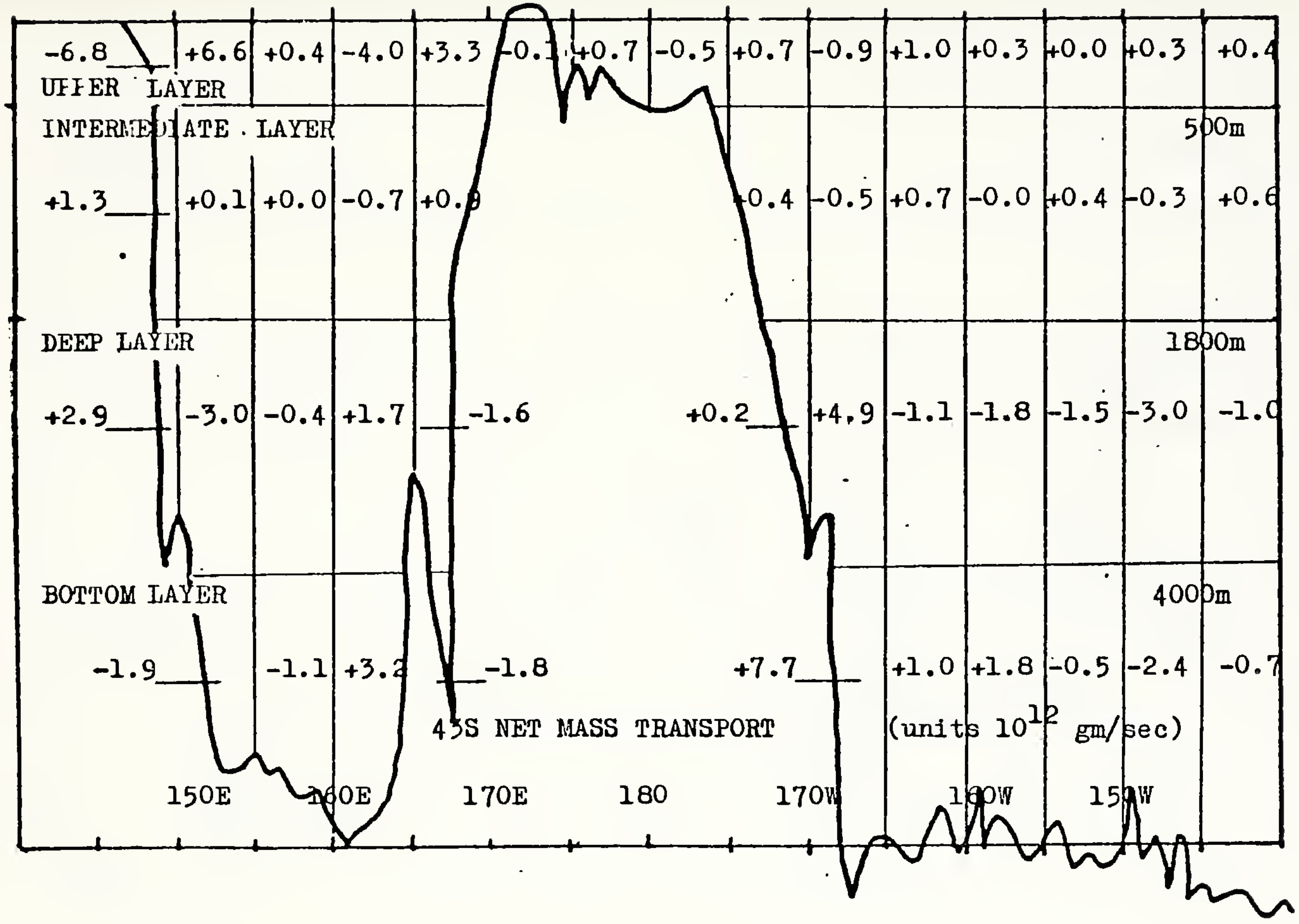

Figure 14. Mass Transport 43°S (West Section)

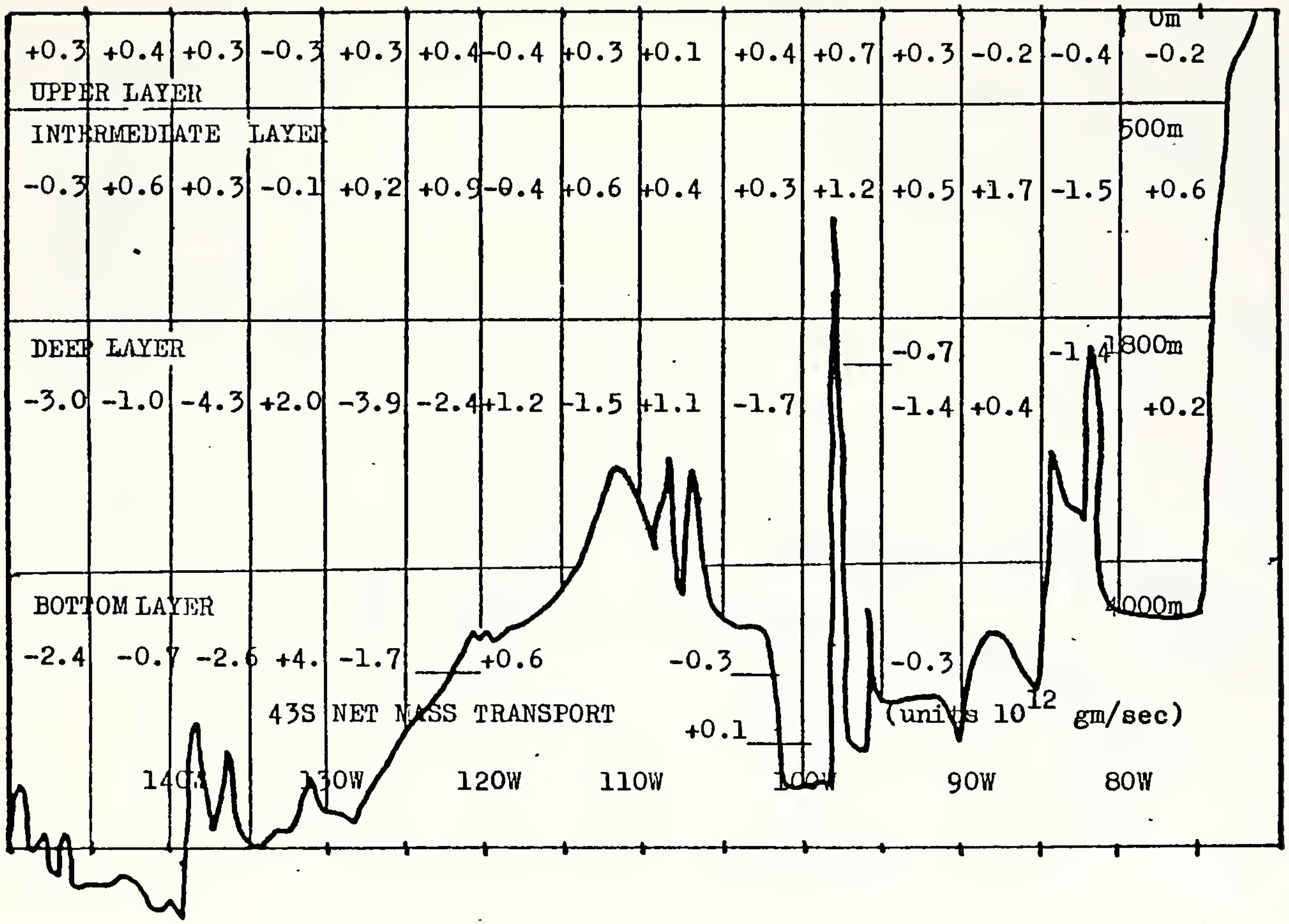

Figure 15. Mass Transport 43°S (East Section)

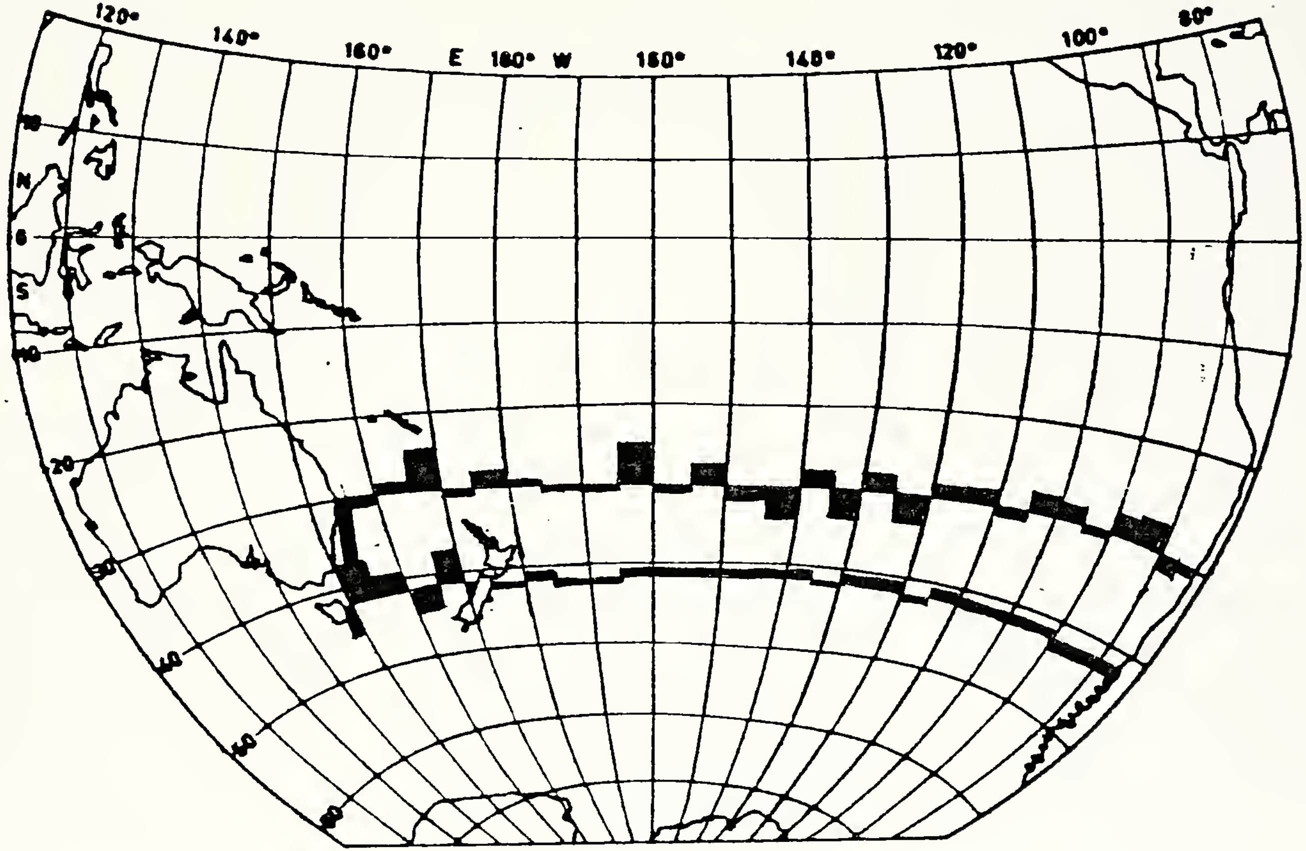

Figure 16. Upper Layer Mass Transport

that this southward flowing current is the subsurface counter current (Gunther, 1936) which has surfaced immediately adjacent to the coast. On the other side of the South Pacific, the south flowing East Australia current is picked up with velocities in general agreement with Scully-Powers (1972). The Upper level was calculated to have a net northward transport of mass, salt and heat at both 28°S and 43°S with the current directions in agreement with traditional theory (Sverdrup et al., 1942).

2. Intermediate Circulation

The Intermediate Layer was roughly between 500m and 1800m in both latitudinal tracks. Whether or not the circulation was cyclonic or anticyclonic was undetermined (Figure 17). Along the 28°S transit there was a net southward transport of mass, salt and heat. This is contrasted with the 43°S transit which has a net northward transport of mass, salt and heat. In the Tasman/Coral Sea area there were net northward transports in both transits.

3. Deep Circulation

As was mentioned previously in Section IV. p. 42, there is the possibility of cyclonic deep and bottom circulation in the South Pacific. Included in this circulation pattern are strong western boundary currents with weaker broader southern currents to the east. The data as illustrated in Figure 18 could be interpreted to have a cyclonic pattern. The Deep Water along both transits had a net southward transport. The western boundaries seemed to have a stronger net

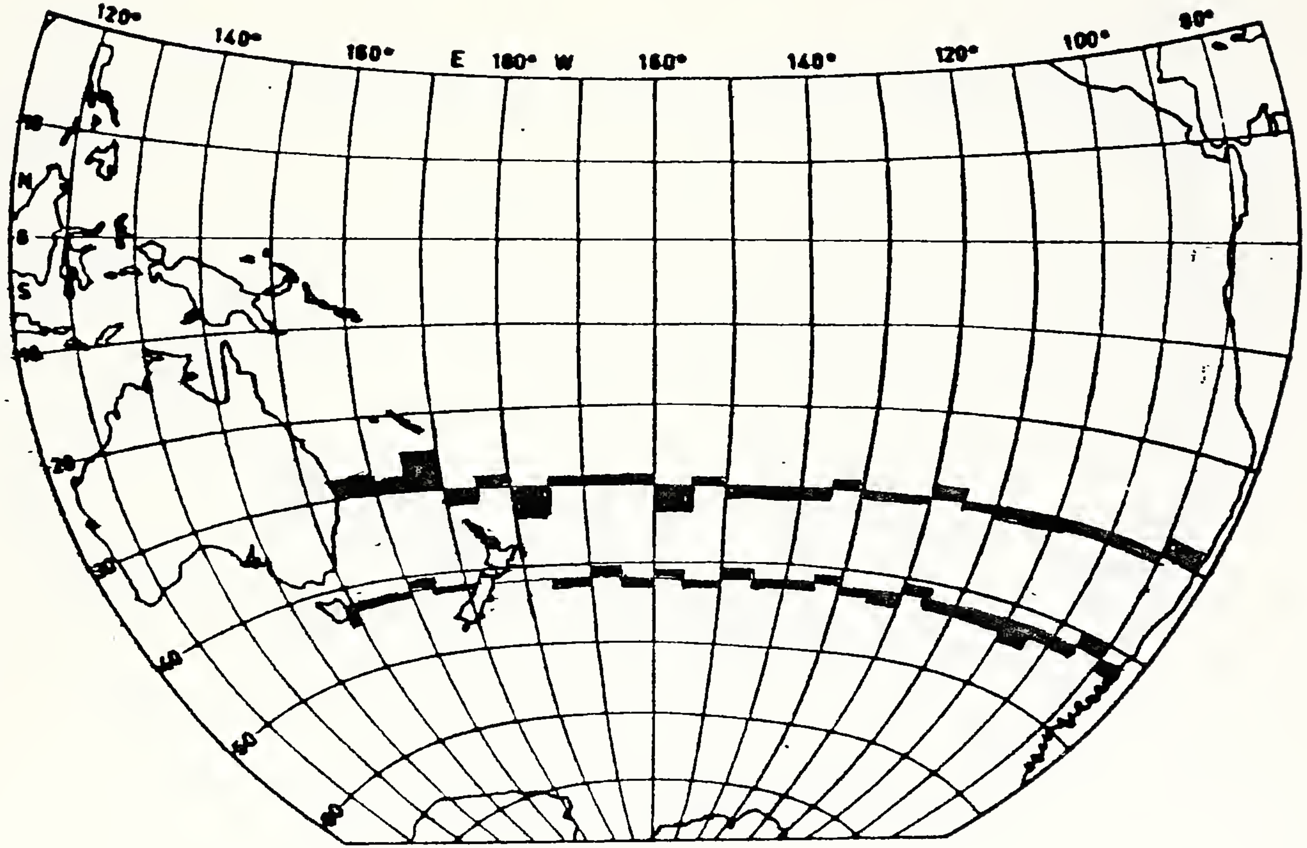

Figure 17. Intermediate Layer Mass Transport

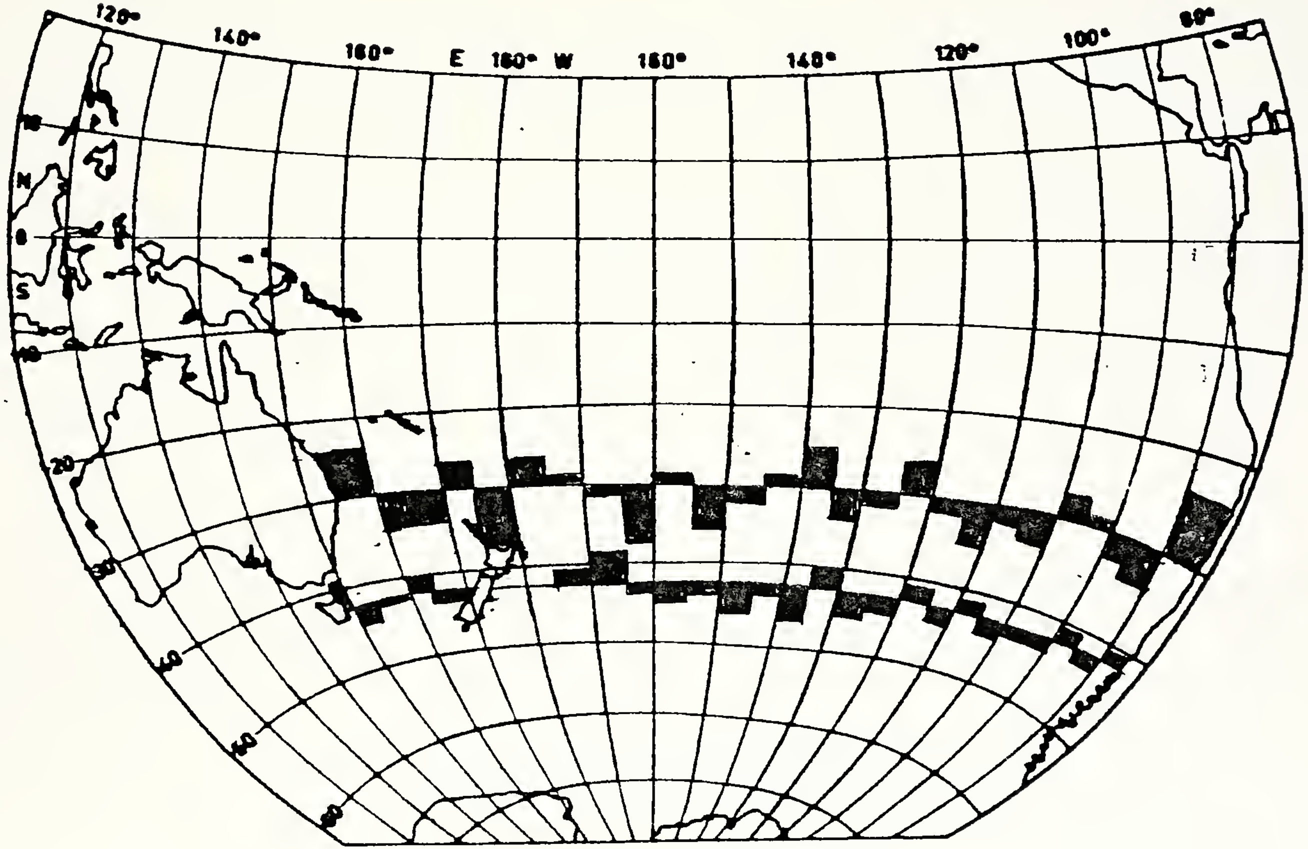

Figure 18. Deep Layer Mass Transport

northward flow. The Tasman/Coral Sea did appear cyclonic in circulation; however the pattern in the general South Pacific east of that area was not as clear.

4. Bottom Circulation

The Bottom Layer as previously discussed is thought to have a cyclonic circulation with strong western boundary currents (Figure 19). In the bottom water detected along the 28°S track, this cyclonic circulation indeed was the case. Also along the 43°S track, east of the New Zealand Plateau, there was strong geostrophic evidence of this. In the Tasman Sea along 43°S the circulation was not cyclonic, but anti-cyclonic with a net southward transport. For the total transit along both latitude sections the net mass, salt and heat transport was to the north.

Interest is drawn to the Tonga-Kermadec Trench located along 28°S at approximately 176°W and extending to a depth in the neighborhood of 8700m. Gilmour (1972) reported a northward current against the western boundary of the ridge with a southerly counter current over the central trench with a broad northerly current on the eastern side. This was at a depth of 4000m. Reid _et_ _al_. (1968) wrote, based on the SCORPIO data, of a narrow (70 km wide) northern boundary current flowing between 2500 and 4000m east of the Tonga-Kermadec Ridge (in the trench). Reid (1970) reported a southerly flow at 1000m and a northerly flow at 3000m. The results of this study are in agreement with Reid in that over the trench (station pair 150-149) a southward current was found between

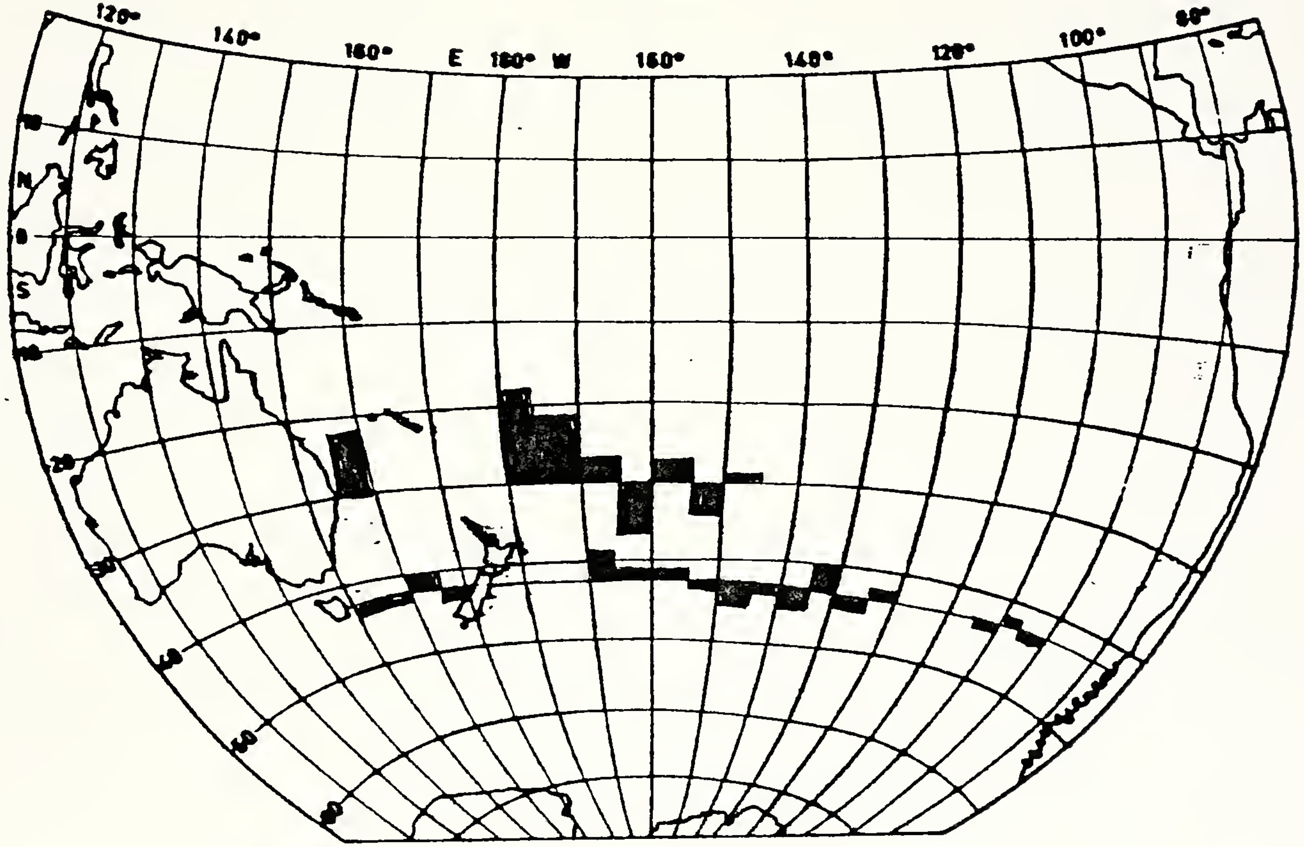

Figure 19. Bottom Layer Mass Tranport

1100m and 3200m with a northward flow below. These results, especially concerning bottom circulation, agree with others which have been mentioned.

VI. CONCLUSIONS

Reid (1961) once wrote that in areas where data is lacking, geostrophic currents can be accepted with some confidence. Using the procedures set forth by Jung (1955), this study attempted to determine: (1) a level of no motion in the South Pacific dependent upon the principles of mass and salt conservation; (2) the direction of heat transport in the South Pacific; and (3) a four-vertically-layered circulation pattern computed by mass transport values under the geostrophic assumption and mass continuity.

Levels of no motion were calculated according to the procedure of Sverdrup _et al_. (1942) to be about 762m (28°S) and 1203m (43°S).

The current circulation for the Upper Layer was determined to be anticyclonic while the Bottom Layer was cyclonic. The Intermediate and Deep Layer patterns could not be determined with good confidence. The Upper Layer had a net northern transport at both latitudes, while the Intermediate Layer had southern transport at 28°S and a northern transport at 43°S. The Deep Layer had a southern transport along both latitudes. The Bottom Layer had, as expected, a net northern transport. Known eddies off the east coast of Australia and New Zealand were located and deep trench circulation patterns were found.

Along both latitude lines, there was determined a net northward heat flow of 33 and 70 x 10^{12} cal/sec. A change of only 1 or 2% of the heat attributed to deep and bottom transport could easily have negated this northward transport. Given the initial assumptions made, this slight northward transport value is probably within the range of error for this study.

APPENDIX A

OCEANOGRAPHIC STATIONS

The stations are listed West to East along both latitudes.

Station Number	Latitude	Longitude
185	28° 11.4'S	153° 50.0'E
184	28° 20.0'S	154° 03.4'E
183	28° 22.0'S	154° 20.5'E
182	28° 14.6'S	154° 45.6'E
181	28° 14.3'S	155° 15.2'E
180	28° 14.2'S	155° 50.7'E
179	28° 10.3'S	156° 33.7'E
178	28° 09.4'S	157° 11.2'E
177	28° 14.9'S	158° 07.0'E
176	28° 14.7'S	159° 02.5'E
175	28° 15.2'S	160° 05.5'E
174	28° 18.9'S	160° 56.8'E
173	28° 15.3'S	161° 55.4'E
172	28° 12.1'S	162° 51.4'E
171	28° 13.5'S	163° 50.0'E
170	28° 12.1'S	164° 43.6'E
169	28° 09.7'S	165° 44.8'E
168	28° 11.5'S	166° 45.4'E
167	28° 14.8'S	167° 36.3'E
166	28° 15.2'S	168° 38.5'E
165	28° 19.0'S	169° 28.7'E
164	28° 11.6'S	171° 06.0'E
163	28° 09.1'S	172° 56.2'E
162	28° 16.5'S	174° 47.4'E
161	28° 11.7'S	175° 46.0'E
160	28° 10.1'S	176° 37.6'E
159	28° 15.8'S	177° 33.5'E
158	28° 12.2'S	178° 26.9'E
157	28° 13.2'S	179° 21.0'E
156	28° 10.6'S	179° 32.0'W
155	28° 11.3'S	178° 38.9'W
154	28° 15.4'S	177° 44.0'W
153	28° 16.2'S	177° 26.7'W
152	28° 17.0'S	177° 04.7'W
151	28° 18.3'S	176° 27.6'W
150	28° 15.7'S	176° 10.0'W
149	28° 15.5'S	175° 49.5'W
148	28° 10.0'S	174° 50.7'W
147	28° 07.2'S	173° 58.0'W
146	28° 11.6'S	173° 07.3'W
145	28° 19.4'S	171° 36.0'W
144	28° 15.7'S	170° 14.8'W
143	28° 16.5'S	168° 49.5'W
142	28° 18.0'S	167° 27.0'W

141	28° 13.9'S	165° 42.4'W
140	28° 12.6'S	163° 51.2'W
139	28° 17.1'S	161° 59.0'W
138	28° 16.1'S	160° 06.1'W
137	28° 12.5'S	158° 12.0'W
136	28° 17.6'S	156° 16.0'W
135	28° 15.6'S	154° 26.0'W
134	28° 13.4'S	152° 36.0'W
133	28° 14.6'S	150° 51.0'W
132	28° 13.8'S	148° 47.0'W
131	28° 14.2'S	146° 51.5'W
130	28° 15.0'S	145° 01.9'W
129	28° 14.1'S	143° 09.1'W
128	28° 15.1'S	141° 11.2'W
127	28° 13.6'S	139° 20.3'W
126	28° 18.8'S	137° 26.8'W
125	28° 18.0'S	135° 37.2'W
124	28° 17.6'S	133° 46.4'W
123	28° 17.5'S	131° 56.5'W
122	28° 16.0'S	130° 02.8'W
121	28° 14.3'S	128° 06.9'W
120	28° 14.1'S	126° 13.0'W
119	28° 15.0'S	124° 21.5'W
118	28° 15.5'S	122° 24.0'W
117	28° 13.0'S	120° 31.7'W
116	28° 15.5'S	118° 39.8'W
115	28° 14.2'S	116° 50.0'W
114	28° 16.0'S	114° 56.4'W
113	28° 17.7'S	113° 00.5'W
112	28° 15.6'S	111° 12.1'W
111	28° 15.1'S	109° 16.6'W
110	28° 14.9'S	107° 25.6'W
109	28° 14.2'S	105° 28.7'W
108	28° 16.2'S	103° 36.8'W
107	28° 14.2'S	101° 39.2'W
106	28° 12.5'S	99° 54.8'W
105	28° 13.9'S	97° 54.7'W
104	28° 12.6'S	95° 59.3'W
103	28° 14.6'S	94° 13.2'W
102	28° 13.6'S	92° 19.9'W
101	28° 15.0'S	90° 27.0'W
100	28° 14.6'S	88° 33.4'W
99	28° 15.1'S	86° 35.5'W
98	28° 15.1'S	84° 46.9'W
97	28° 15.3'S	84° 46.9'W
96	28° 15.8'S	80° 59.7'W
95	28° 15.7'S	79° 07.3'W
94	28° 18.4'S	77° 09.8'W
93	28° 14.6'S	75° 21.3'W
92	28° 12.8'S	74° 35.8'W
91	28° 15.4'S	73° 41.6'W
90	28° 15.0'S	72° 55.0'W
89	28° 16.5'S	72° 04.9'W
88	28° 15.1'S	71° 39.4'W

87	28° 15.0'S	71° 18.3'W
86	28° 15.8'S	71° 15.0'W

1	43° 15.1'S	148° 12.8'E
2	43° 16.5'S	148° 23.3'E
3	43° 17.0'S	148° 39.5'E
4	43° 13.0'S	149° 20.0'E
5	43° 15.0'S	150° 28.0'E
6	43° 15.1'S	152° 07.5'E
7	43° 15.0'S	154° 24.0'E
8	43° 14.6'S	156° 37.3'E
9	43° 14.0'S	158° 48.8'E
10	43° 12.6'S	161° 04.0'E
11	43° 17.7'S	163° 18.7'E
12	43° 17.2'S	165° 38.0'E
13	43° 16.2'S	166° 43.5'E
14	43° 12.0'S	167° 22.5'E
15	43° 12.6'S	168° 12.8'E
16	43° 13.5'S	169° 38.0'E
17	43° 14.0'S	173° 51.3'E
18	43° 16.4'S	174° 36.0'E
19	43° 11.8'S	175° 45.7'E
20	43° 16.3'S	177° 36.1'E
21	43° 14.9'S	179° 15.8'E
22	43° 14.2'S	179° 00.0'W
23	43° 11.5'S	177° 22.3'W
24	43° 12.3'S	175° 28.0'W
25	43° 15.5'S	173° 50.4'W
26	43° 19.0'S	172° 42.0'W
27	43° 16.5'S	171° 42.2'W
28	43° 13.6'S	170° 41.9'W
29	43° 15.0'S	169° 50.0'W
30	43° 15.0'S	169° 04.5'W
31	43° 15.9'S	168° 30.6'W
32	43° 15.2'S	167° 53.5'W
33	43° 12.6'S	166° 47.0'W
34	43° 13.1'S	164° 31.6'W
35	43° 13.8'S	162° 09.0'W
36	43° 12.5'S	159° 50.0'W
37	43° 14.5'S	157° 30.0'W
38	43° 13.8'S	155° 11.5'W
39	43° 15.5'S	152° 53.0'W
40	43° 16.0'S	150° 35.0'W
41	43° 17.2'S	148° 18.8'W
42	43° 15.5'S	146° 03.3'W
43	43° 15.4'S	143° 43.0'W
44	43° 15.0'S	141° 26.0'W
45	43° 13.8'S	139° 11.8'W
46	43° 16.1'S	136° 47.0'W
47	43° 13.0'S	134° 27.2'W

48	43° 12.7'S	132° 14.6'W
49	43° 15.8'S	129° 53.6'W
50	43° 15.2'S	127° 36.0'W
51	43° 15.3'S	125° 19.8'W
52	43° 16.3'S	123° 02.8'W
53	43° 15.0'S	120° 40.2'W
54	43° 17.9'S	118° 23.8'W
55	43° 18.4'S	116° 05.1'W
56	43° 16.1'S	113° 48.1'W
57	43° 15.8'S	112° 27.5'W
58	43° 14.8'S	109° 12.1'W
59	43° 15.5'S	106° 54.4'W
60	43° 15.1'S	104° 34.0'W
61	43° 15.0'S	102° 19.0'W
62	43° 15.4'S	99° 59.0'W
63	43° 13.8'S	97° 38.0'W
64	43° 18.6'S	95° 34.1'W
65	43° 14.2'S	93° 24.3'W
66	43° 16.5'S	90° 49.5'W
67	43° 15.0'S	88° 31.0'W
68	43° 14.0'S	86° 11.0'W
69	43° 15.0'S	83° 52.6'W
70	43° 15.0'S	81° 40.9'W
71	43° 14.7'S	80° 02.0'W
72	43° 19.0'S	79° 01.5'W
73	43° 15.6'S	78° 01.2'W
74	43° 16.6'S	77° 01.3'W
75	43° 12.8'S	76° 04.2'W
76	43° 15.0'S	75° 30.0'W
77	43° 17.0'S	75° 24.1'W
78	43° 15.6'S	75° 07.2'W

APPENDIX B

GEOSTROPHIC DATA

The following pages contain the net mass, salt and heat transports for each of the Upper, Intermediate, and Deep, and Bottom Layers (combinations of water masses) between each pair of stations observed along the two latitudes of this study. Each water layer is further subdivided by water mass. All mass transport values are expressed in terms of 10^{12} gm/sec. The salt transport units are 10^{12} °/oo/sec and the heat transport units are 10^{12} cal/sec.

The following number system is used in this appendix:

1. = Peru Surface Water
2. = South-Central Subtropic Surface Water
3. = Surface Water of South Temperate Latitude
4. = South Subtropical Surface Water
5. = South Pacific Intermediate Water
6. = South Pacific Upper Deep
7. = Underlying Deep Water
8. = Antarctic Bottom Water
9. = Pacific Bottom Water

Unknown = Unclassified Water Mass

\- Indicates southward flow

Mass Transport 28° 15.'S

Station Pair	Upper Total	1	2	3	4	Unknown
185-184	-0.204				-0.061	-0.143
184-183	-6.019		-3.175		-2.844	
183-182	-2.706		-1.319		-1.387	
182-181	5.269		3.213		2.056	
181-180	-2.626		-1.029		-1.597	
180-179	-1.174		-0.496		-0.678	
179-178	-3.554		-1.586		-1.968	
178-177	1.563		0.715		0.848	
177-176	-0.106		-0.048		-0.058	
176-175	1.638		0.831		0.807	
175-174	1.296		0.487		0.809	
174-173	1.988		0.883		1.106	
173-172	0.883		-0.052		0.934	
172-171	-2.108		-0.407		-1.701	
171-170	-2.396		-0.448		-1.948	
170-169	1.410		0.284		1.127	
169-168	1.767		0.696		1.071	
168-167	3.911		1.374		2.537	
167-166	-0.301				-0.301	
166-165	-2.009		-0.760		-1.250	
165-164	-4.492		-1.520		-2.972	
164-163	7.649		2.139		5.510	
163-162	-3.644		-0.545		-3.100	
162-161	-2.954		-0.842		-2.112	
161-160	1.181		0.228		0.953	
160-159	0.561		0.281		0.280	
159-158	3.025		0.525		2.500	
158-157	0.013		-0.093		0.106	
157-156	-4.390		-1.524		-2.866	
156-155	3.070		1.217		1.853	
155-154	3.230				3.230	
154-153	0.172				0.172	
153-152	-0.368		-0.074		-0.294	
152-151	-0.032		-0.018		-0.014	
151-150	-0.383		-0.155		-0.227	
150-149	-0.954		-0.127		-0.827	
149-148	-3.162		-1.065		-2.096	
148-147	3.775		1.545		2.230	
147-146	0.673				0.673	
146-145	0.318				0.318	
145-144	-2.820		-0.517		-2.303	
144-143	2.117		0.360		1.757	
143-142	-0.446		-0.062		-0.384	
142-141	-3.298		-1.304		-1.995	
141-140	1.598		0.715		0.883	
140-139	4.056		1.451		2.606	
139-138	-0.330		-0.194		-0.135	
138-137	-0.118		0.051		-0.169	

Station Pair	Upper Total	1	2	3	4	Unknown
137-136	1.195		-0.315		-0.880	
136-135	2.589		0.573		2.017	
135-134	0.883		0.148		0.735	
134-133	-0.054		-0.169		0.115	
133-132	-0.950	-0.212	-0.172		-0.567	
132-131	0.167	0.003			0.163	
131-130	-0.690	-0.590			-0.100	
130-129	-2.963	-1.270			-1.692	
129-128	-0.782	-0.427			-0.355	
128-127	4.096	2.101			1.995	
127-126	0.117	-0.108			0.225	
126-125	-2.296	-0.395	-0.904		-0.997	
125-124	-1.100	-0.224	-0.523		-0.354	
124-123	1.408	0.264	0.498		0.645	
123-122	-3.160		-1.605		-1.555	
122-121	-1.545		-0.822		-0.723	
121-120	3.445		1.754		1.691	
120-119	-3.521		-1.867		-1.655	
119-118	2.507		1.284		1.223	
118-117	-2.910		-1.256		-1.654	
117-116	4.202		1.958		2.244	
116-115	-1.788	-0.319	-0.642		-0.827	
115-114	3.793	0.604	1.353		1.836	
114-113	0.149	0.061	0.023		0.065	
113-112	-1.501	-0.274	-0.583		-0.643	
112-111	0.813		0.402		0.411	
111-110	0.737	0.071	0.229		0.438	
110-109	-2.410		-1.123		-1.288	
109-108	1.338		0.619		0.719	
108-107	0.561		0.296		0.265	
107-106	-0.179	-0.018	0.018		-0.179	
106-105	0.727	0.189	0.097		0.440	
105-104	0.823	0.356			0.466	
104-103	0.839	0.474		0.107	0.259	
103-102	-1.690	-0.823		-0.221	-0.645	
102-101	0.554	0.837		0.091	-0.374	
101-100	2.215	0.450		0.401	1.365	
100-099	0.157	0.021		0.045	0.091	
099-098	0.779	0.589		0.214	-0.024	
098-097	-0.116	0.037		-0.053	-0.100	
097-096	2.278	0.870		0.936	0.471	
096-095	-0.170	-0.183		-0.015	0.029	
095-094	0.961	0.453		0.402	0.106	
094-093	-2.894			-1.293	-1.601	
093-092	4.423			2.264	2.159	
092-091	2.097			1.197	0.281	0.619
091-090	-0.323			-0.274	-0.049	
090-089	-1.237			-0.724	-0.513	
089-088	-1.823	-0.275		-1.131	-0.418	
088-087	-3.335	-0.099		-1.771	-1.465	
087-086	0.002			0.002		
Total	4.597					

Salt Transport 28° 15.0'S

Station Pair	Upper Total	1	2	3	4	Unknown
185-184	-7.242				-2.183	-5.059
184-183	-213.278		-112.900		-100.378	
183-182	-96.104		-46.977		-49.127	
182-181	187.109		114.361		72.748	
181-180	-93.212		-36.672		-56.540	
180-179	-41.652		-17.692		-23.961	
179-178	-126.326		-56.580		-69.746	
178-177	55.521		25.519		30.002	
177-176	-3.735		-1.720		-2.015	
176-175	58.321		29.673		28.647	
175-174	46.024		17.386		28.638	
174-173	70.577		31.486		39.091	
173-172	30.888		-1.838		32.726	
172-171	-74.438		-14.504		-59.933	
171-170	-84.893		-15.978		-68.915	
170-169	50.068		10.124		39.944	
169-168	62.689		24.846		37.843	
168-167	138.958		49.053		89.905	
167-166	-10.733				-10.733	
166-165	-71.387		-27.135		-44.252	
165-164	-159.235		-54.254		-104.980	
164-163	271.225		76.332		194.893	
163-162	-129.093		-19.463		-109.629	
162-161	-104.818		-30.026		-74.792	
161-160	41.832		8.135		33.698	
160-159	19.987		10.023		9.965	
159-158	107.328		18.731		88.597	
158-157	0.300		-3.320		3.620	
157-156	-155.633		-54.407		-101.226	
156-155	109.056		43.438		65.618	
155-154	114.584				114.584	
154-153	6.066				6.066	
153-152	-13.063		-2.645		-10.418	
152-151	-1.154		-0.637		-0.517	
151-150	-13.736		-5.554		-8.182	
150-149	-33.739		-4.546		-29.193	
149-148	-112.143		-38.031		-74.112	
148-147	134.115		55.139		78.975	
147-146	23.805				23.805	
146-145	11.147				11.147	
145-144	-100.147		-18.460		-81.688	
144-143	75.156		12.852		62.304	
143-142	-15.805		-2.223		-13.582	
142-141	-117.280		-46.571		-70.709	
141-140	56.706		25.526		31.180	
140-139	143.948		51.789		92.159	
139-138	-11.888		-6.930		-4.958	
138-137	-4.104		1.811		-5.915	
137-136	-42.399		-11.197		-31.202	

Station Pair	Upper Total	1	2	3	4	Unknown
136-135	91.789		20.370		71.419	
135-134	31.160		5.273		25.887	
134-133	-2.059		-6.008		3.949	
133-132	-33.600	-7.512	-6.096		-19.992	
132-131	5.826	0.122			5.704	
131-130	-24.401	-20.871			-3.530	
130-129	-104.594	-45.043			-59.551	
129-128	-27.592	-15.140			-12.452	
128-127	144.527	74.448			70.079	
127-126	4.081	-3.830			7.911	
126-125	-81.199	-14.017	-32.138		-35.044	
125-124	-38.960	-7.927	-18.589		-12.443	
124-123	49.756	9.372	17.719		22.665	
123-122	-111.714		-57.150		-54.564	
122-121	-54.726		-29.308		-25.418	
121-120	121.814		62.528		59.286	
120-119	-124.689		-66.620		-58.069	
119-118	88.794		45.839		42.955	
118-117	-102.882		-44.886		-57.996	
117-116	148.441		69.834		78.607	
116-115	-63.250	-11.334	-22.953		-28.964	
115-114	133.894	21.409	48.305		64.180	
114-113	5.229	2.144	0.806		2.279	
113-112	-53.016	-9.711	-20.784		-22.521	
112-111	28.741		14.351		14.390	
111-110	25.885	2.512	8.164		15.209	
110-109	-85.015		-40.079		-44.936	
109-108	47.230		22.122		25.108	
108-107	19.768		10.526		9.242	
107-106	-6.213	-0.627	0.631		-6.218	
106-105	25.449	6.704	3.452		15.292	
105-104	28.772	12.598			16.174	
104-103	29.377	16.708		3.702	8.967	
103-102	-58.937	-29.004		-7.635	-22.297	
102-101	19.644	29.387		3.152	-12.894	
101-100	76.602	15.733		13.807	47.062	
100-099	5.406	0.748		1.532	3.126	
099-098	27.145	20.584		7.393	-0.832	
098-097	-3.968	1.269		-1.804	-3.434	
097-096	78.345	30.067		32.059	16.219	
096-095	-5.863	-6.339		-0.520	0.995	
095-094	33.038	15.611		13.769	3.658	
094-093	-99.996			-44.564	-55.432	
093-092	152.745			78.104	74.641	
092-091	72.033			41.145	9.695	21.194
091-090	-11.141			-9.436	-1.706	
090-089	-42.548			-24.896	-17.652	
089-088	-62.947	-9.473		-39.019	-14.454	
088-087	-115.659	-3.414		-61.403	-50.842	
087-086	0.069			0.069		
Total	158.765					

Heat Transport 28° 15.0'S

Station Pair	Upper Total	1	2	3	4	Unknown
185-184	-59.782				-17.953	-41.829
184-183	-1751.812	-932.054	-932.054		-819.758	-41.829
183-182	-790.568		-388.548		-402.020	
182-181	1538.372		943.312		595.060	
181-180	-764.410		-302.131		-462.279	
180-179	-341.202		-145.522		-195.680	
179-178	-1035.459		-465.151		-570.308	
178-177	455.043		209.782		245.261	
177-176	-30.514		-14.132		-16.381	
176-175	477.918		243.618		234.300	
175-174	376.586		142.719		233.867	
174-173	577.762		258.611		319.151	
173-172	251.512		-15.125		266.636	
172-171	-608.130		-119.215		-488.915	
171-170	-694.034		-131.338		-562.696	
170-169	409.466		83.160		326.306	
169-168	512.715		203.972		308.743	
168-167	1136.044		402.215		733.829	
167-166	-87.722				-87.722	
166-165	-583.327		-222.306		-361.022	
165-164	-1301.005		-445.207		-855.798	
164-163	2214.865		625.692		1589.173	
163-162	-1053.420		-159.435		-893.985	
162-161	-856.662		-246.607		-610.054	
161-160	341.668		66.864		274.804	
160-159	163.728		82.293		81.435	
159-158	876.738		153.590		723.148	
158-157	2.084		-27.232		29.316	
157-156	-1273.071		-446.980		-826.091	
156-155	892.386		356.762		535.625	
155-154	935.169				935.169	
154-153	49.331				49.331	
153-152	-106.607		-21.639		-84.968	
152-151	-9.437		-5.213		-4.224	
151-150	-112.526		-45.541		-66.985	
150-149	-275.408		-37.301		-238.107	
149-148	-917.000		-312.328		-604.671	
148-147	1096.400		452.155		644.245	
147-146	194.052				194.052	
146-145	90.724				90.724	
145-144	-817.891		-151.396		-666.496	
144-143	613.629		105.292		508.338	
143-142	-128.940		-18.198		-110.742	
142-141	-958.906		-381.726		-577.180	
141-140	463.771		209.391		254.380	
140-139	1176.566		424.568		751.998	
139-138	-97.614		-56.831		-40.783	
138-137	-33.394		14.860		-48.254	

Station Pair	Upper Total	1	2	3	4	Unknown
137-136	-347.357		-92.075		-255.282	
136-135	751.986		167.692		584.294	
135-134	254.675		43.340		211.335	
134-133	-17.505		-49.479		31.974	
133-132	-275.610	-62.079	-50.229		-163.301	
132-131	47.487	0.918			46.569	
131-130	-201.601	-172.752			-28.849	
130-129	-859.335	-372.501			-486.834	
129-128	-227.261	-125.401			-101.860	
128-127	1189.068	615.827			573.242	
127-126	32.850	-31.853			64.703	
126-125	-668.687	-115.284	-266.296		-287.106	
125-124	-321.643	-65.382	-154.028		-102.232	
124-123	410.355	77.380	146.825		186.150	
123-122	-920.672		-472.545		-448.127	
122-121	-451.207		-242.161		-209.045	
121-120	1003.824		516.353		487.470	
120-119	-1027.494		-549.478		-478.016	
119-118	731.727		378.167		353.560	
118-117	-847.038		-369.998		-477.039	
117-116	1222.520		575.896		646.625	
116-115	-521.255	-93.599	-189.117		-238.540	
115-114	1103.503	176.766	398.088		528.650	
114-113	43.142	17.733	6.665		18.744	
113-112	-436.984	-80.173	-171.458		-185.353	
112-111	236.777		118.241		118.536	
111-110	213.247	20.732	67.276		125.238	
110-109	-700.104		-329.812		-370.292	
109-108	388.644		181.832		206.812	
108-107	162.938		86.700		76.238	
107-106	-51.303	-5.177	5.204		-51.330	
106-105	210.170	55.371	28.476		126.323	
105-104	237.952	104.196			133.757	
104-103	243.424	138.396		30.736	74.292	
103-102	-488.411	-240.418		-63.446	-184.547	
102-101	165.265	244.008		26.150	-104.893	
101-100	631.627	130.943		114.811	385.872	
100-099	44.894	6.224		12.749	25.922	
099-098	226.181	171.401		61.545	-6.766	
098-097	-32.556	10.616		-15.004	-28.169	
097-096	653.104	252.598		267.535	132.972	
096-095	-49.483	-53.238		-4.408	8.163	
095-094	276.185	131.361		114.861	29.963	
094-093	-821.394			-368.426	-452.923	
093-092	1259.124			645.471	613.652	
092-091	599.012			341.112	79.160	178.740
091-090	-91.736			-77.805	-13.931	
090-089	-353.827			-206.171	-147.656	
089-088	-520.306	-79.558		-322.667	-118.082	
088-087	-949.172	-28.527		-505.227	-415.418	
087-086	0.578			-0.578		
Total	1316.051					

Mass Transport 28° 15.'S

Station Pair	Intermediate Total	5
185-184		
184-183	0.950	0.950
183-182	2.735	2.735
182-181	0.953	0.953
181-180	-0.061	-0.061
180-179	-0.378	-0.378
179-178	2.603	2.603
178-177	-2.708	-2.708
177-176	1.258	1.258
176-175	-0.679	-0.679
175-174	-0.603	-0.603
174-173	-0.428	-0.428
173-172	-0.809	-0.809
172-171	0.705	0.705
171-170	6.475	6.475
170-169	-2.651	-2.651
169-168	-1.625	-1.625
168-167	0.103	0.103
167-166	-0.332	-0.332
166-165	1.738	1.738
165-164	5.066	5.066
164-163	-9.265	-9.265
163-162	5.381	5.381
162-161	1.111	1.111
161-160	-1.833	-1.833
160-159	0.672	0.672
159-158	-2.522	-2.522
158-157	-2.341	-2.341
157-156	2.473	2.473
156-155	-0.001	-0.001
155-154	-0.193	-0.193
154-153	0.048	0.048
153-152	-3.154	-3.154
152-151	0.753	0.753
151-150	0.525	0.525
150-149	-0.334	-0.334
149-148	2.873	2.873
148-147	-2.962	-2.962
147-146	-0.370	-0.370
146-145	-0.195	-0.195
145-144	1.576	1.576
144-143	-0.815	-0.815
143-142	-0.545	-0.545
142-141	1.461	1.461
141-140	-1.432	-1.432
140-139	-1.875	-1.875
139-138	-0.415	-0.415
138-137	0.336	0.336

Station Pair	Intermediate Total	5
137-136	-0.001	-0.001
136-135	-0.211	-0.211
135-134	-0.320	-0.320
134-133	-0.428	-0.428
133-132	-0.273	-0.273
132-131	-1.339	-1.339
131-130	0.786	0.786
130-129	0.540	0.540
129-128	-0.792	-0.792
128-127	0.361	0.361
127-126	-0.898	-0.898
126-125	1.596	1.596
125-124	-1.107	-1.107
124-123	0.222	0.222
123-122	0.059	0.059
122-121	0.062	0.062
121-120	-0.679	-0.679
120-119	0.107	0.107
119-118	1.112	1.112
118-117	-0.697	-0.697
117-116	-1.020	-1.020
116-115	0.873	0.873
115-114	-0.991	-0.991
114-113	-0.177	-0.177
113-112	0.167	0.167
112-111	0.181	0.181
111-110	-1.688	-1.688
110-109	0.514	0.514
109-108	-0.038	-0.038
108-107	-0.179	-0.179
107-106	0.116	0.116
106-105	-0.144	-0.144
105-104	-0.256	-0.256
104-103	-0.806	-0.806
103-102	0.289	0.289
102-101	-0.125	-0.125
101-100	-0.605	-0.605
100-099	-0.572	-0.572
099-098	0.034	0.034
098-097	-0.877	-0.877
097-096	-0.307	-0.307
096-095	0.165	0.165
095-094	-0.665	-0.665
094-093	2.386	2.386
093-092	-1.747	-1.747
092-091	-1.869	-1.869
091-090	1.787	1.787
090-089	0.907	0.907
089-088	2.208	2.208
088-087	-0.376	-0.376
087-086		
Total	-3.44	

Salt Transport 28° 15.0'S

Station Pair	Intermediate Total	5
185-184		
184-183	32.766	32.766
183-182	94.625	94.625
182-181	32.991	32.991
181-180	-2.092	-2.092
180-179	-13.072	-13.072
179-178	89.943	89.943
178-177	-93.616	-93.616
177-176	43.492	43.492
176-175	-23.465	-23.465
175-174	-20.851	-20.851
174-173	-14.774	-14.774
173-172	-27.849	-27.849
172-171	24.288	24.288
171-170	223.906	223.906
170-169	-91.698	-91.698
169-168	-56.198	-56.198
168-167	3.567	3.567
167-166	-11.457	-11.457
166-165	60.039	60.039
165-164	175.054	175.054
164-163	-320.065	-320.065
163-162	185.808	185.808
162-161	38.349	38.349
161-160	-63.321	-63.321
160-159	23.186	23.186
159-158	-87.084	-87.084
158-157	-80.845	-80.845
157-156	85.120	85.120
156-155	-0.041	-0.041
155-154	-6.636	-6.636
154-153	1.648	1.648
153-152	-109.077	-109.077
152-151	26.035	26.035
151-150	18.107	18.107
150-149	-11.552	-11.552
149-148	99.185	99.185
148-147	-102.355	-102.355
147-146	-12.740	-12.740
146-145	-6.699	-6.699
145-144	54.367	54.367
144-143	-28.144	-28.144
143-142	-18.801	-18.801
142-141	50.430	50.430
141-140	-49.405	-49.405
140-139	-64.661	-64.661
139-138	-14.301	-14.301
138-137	11.581	11.581

Station Pair	Intermediate Total	5
137-136	-0.033	-0.033
136-135	-7.269	-7.269
135-134	-11.029	-11.029
134-133	-14.781	-14.781
133-132	-9.406	-9.406
132-131	-46.181	-46.181
131-130	27.096	27.096
130-129	18.628	18.628
129-128	-27.321	-27.321
128-127	12.455	12.455
127-126	-30.972	-30.972
126-125	55.077	55.077
125-124	-38.178	-38.178
124-123	7.627	7.627
123-122	2.035	2.035
122-121	2.153	2.153
121-120	-23.441	-23.441
120-119	3.748	3.748
119-118	38.332	38.332
118-117	-24.050	-24.050
117-116	-35.176	-35.176
116-115	30.098	30.098
115-114	-34.184	-34.184
114-113	-6.098	-6.098
113-112	5.750	5.750
112-111	6.247	6.247
111-110	-58.287	-58.287
110-109	17.753	17.753
109-108	-1.345	-1.345
108-107	-6.168	-6.168
107-106	4.012	4.012
106-105	-4.962	-4.962
105-104	-8.861	-8.861
104-103	-27.839	-27.839
103-102	9.986	9.986
102-101	-4.271	-4.271
101-100	-20.962	-20.962
100-099	-19.735	-19.735
099-098	1.173	1.173
098-097	-30.297	-30.297
097-096	-10.654	-10.654
096-095	5.687	5.687
095-094	-23.030	-23.030
094-093	82.544	82.544
093-092	-60.443	-60.443
092-091	-64.654	-64.654
091-090	61.826	61.826
090-089	31.419	31.419
089-088	76.380	76.380
088-087	-12.956	-12.956
087-086		
Total	-118.90	

Heat Transport 28° 15.0'S

Station Pair	Intermediate Total	5
185-184		
184-183	263.562	263.562
183-182	755.656	755.656
182-181	263.393	263.393
181-180	-16.916	-16.916
180-179	-104.651	-104.651
179-178	720.120	720.120
178-177	-748.827	-748.827
177-176	348.113	348.113
176-175	-187.809	-187.809
175-174	-166.640	-166.640
174-173	-118.945	-118.945
173-172	-224.707	-224.707
172-171	195.964	195.964
171-170	1789.362	1789.362
170-169	-732.697	-732.697
169-168	-449.296	-449.296
168-167	28.970	28.970
167-166	-93.008	-93.008
166-165	480.973	480.973
165-164	1400.453	1400.453
164-163	-2562.264	-2562.264
163-162	1488.644	1488.644
162-161	307.375	307.375
161-160	-506.477	-506.477
160-159	185.725	185.725
159-158	-697.062	-697.062
158-157	-647.250	-647.250
157-156	689.142	689.142
156-155	-0.305	-0.305
155-154	-53.862	-53.862
154-153	13.364	13.364
153-152	-870.377	-870.377
152-151	207.858	207.858
151-150	145.120	145.120
150-149	-92.245	-92.245
149-148	793.647	793.647
148-147	-817.954	-817.954
147-146	-102.711	-102.711
146-145	-53.799	-53.799
145-144	435.331	435.331
144-143	-225.018	-225.018
143-142	-150.496	-150.496
142-141	403.450	403.450
141-140	-395.384	-395.384
140-139	-517.744	-517.744
139-138	-114.376	-114.376
138-137	92.485	92.485

Station Pair	Intermediate Total	5
137-136	-0.014	-0.014
136-135	-58.420	-58.420
135-134	-88.115	-88.115
134-133	-117.669	-117.669
133-132	-75.838	-75.838
132-131	-369.677	-369.677
131-130	217.186	217.186
130-129	148.881	148.881
129-128	-219.077	-219.077
128-127	100.146	100.146
127-126	-247.876	-247.876
126-125	440.609	440.609
125-124	-305.658	-305.658
124-123	61.348	61.348
123-122	16.155	16.155
122-121	16.809	16.809
121-120	-186.898	-186.898
120-119	28.727	28.727
119-118	307.278	307.278
118-117	-192.859	-192.859
117-116	-281.343	-281.343
116-115	241.140	241.140
115-114	-273.082	-273.082
114-113	-48.719	-48.719
113-112	45.917	45.917
112-111	49.789	49.789
111-110	-465.416	-465.416
110-109	141.460	141.460
109-108	-10.235	-10.235
108-107	-49.019	-49.019
107-106	31.652	31.652
106-105	-39.318	-39.318
105-104	-70.448	-70.448
104-103	-222.765	-222.765
103-102	79.439	79.439
102-101	-35.790	-35.790
101-100	-165.202	-165.202
100-099	-157.878	-157.878
099-098	9.378	9.378
098-097	-242.507	-242.507
097-096	-83.919	-83.919
096-095	45.667	45.667
095-094	-182.606	-182.606
094-093	656.704	656.704
093-092	-480.336	-480.336
092-091	-515.086	-515.086
091-090	492.901	492.901
090-089	249.374	249.374
089-088	608.284	608.284
088-087	-105.954	-105.954
087-086		
Total	-945.001	

Mass Transport 28° 15.'S

Station Pair	Deep/ Bottom Total	6	7	8	9
185-184					
184-183					
183-182	6.887	6.887			
182-181	9.163	1.815	2.025		5.323
181-180	3.963	1.038	1.552		1.373
180-179	-3.671	-0.366	-0.834		-2.471
179-178	6.198	1.956	1.850		2.392
178-177	-1.990	-1.990			
177-176	0.724	0.724			
176-175	-0.772	-0.772			
175-174					
174-173					
173-172					
172-171					
171-170					
170-169	-6.917	-6.917			
169-168	-4.109	-4.109			
168-167					
167-166					
166-165	2.169	2.169			
165-164	5.057	5.057			
164-163	-5.374	-5.374			
163-162	5.019	5.019			
162-161	3.168	3.168			
161-160	-7.460	-7.460			
160-159	2.130	2.130			
159-158	-7.425	-5.440	-1.984		
158-157	-4.330	-4.330			
157-156					
156-155					
155-154					
154-153					
153-152					
152-151	3.551	2.067	1.484		
151-150	9.468	1.076	2.584		5.808
150-149	5.568	-0.805	-0.196	5.785	0.784
149-148	23.584	6.565	3.274	10.740	3.005
148-147	-20.513	-6.073	-6.574		-7.866
147-146	-0.245	0.131	-0.288		-0.088
146-145	-0.787	-0.859	-0.083	-0.347	0.502
145-144	13.389	3.007	3.452	4.433	2.497
144-143	-7.424	-2.439	-2.862	-1.126	-0.996
143-142	0.537	-0.618	-0.093	0.912	0.336
142-141	11.170	2.832	2.972	3.845	1.522
141-140	-6.072	-2.832	-3.352	0.191	-0.078
140-139	-24.599	-4.890	-8.259	-11.450	
139-138	-2.767	-1.065	-1.040	-0.662	
138-137	1.171	0.511	0.392	0.268	

Station Pair	Deep/ Bottom Total	6	7	8	9
137-136	5.609	0.999	1.419	3.192	
136-135	-6.598	-1.215	-2.135	-3.248	
135-134	-3.520	-0.391	-2.174	-0.524	-0.431
134-133	-5.782	-1.707	-2.111		-1.963
133-132	4.839	0.990	2.403		1.446
132-131	-13.116	-3.892	-6.628	-1.497	-1.100
131-130	5.262	1.677	2.386	0.683	0.516
130-129	2.332	1.385	0.947		
129-128	-1.549	-1.010	-0.539		
128-127	-0.754	0.127	-0.882		
127-126	-2.283	-1.924	-0.359		
126-125	8.191	2.713	5.478		
125-124	-7.174	-2.039	-5.135		
124-123	0.576	0.123	0.454		
123-122	1.435	0.487	0.948		
122-121	1.878	0.583	1.295		
121-120	-5.650	-1.979	-3.671		
120-119	3.584	1.237	2.347		
119-118	2.925	1.266	1.658		
118-117	-2.039	-0.918	-1.121		
117-116	-4.513	-2.509	-2.003		
116-115	2.490	1.096	1.395		
115-114	-3.935	-2.202	-1.733		
114-113	-1.028	-1.028			
113-112	0.140	0.140			
112-111	1.978	1.343	0.636		
111-110	-5.244	-5.244			
110-109	1.932	1.932			
109-108	-1.712	-1.712			
108-107	-0.405	-0.030	-0.375		
107-106	3.145	1.185	1.961		
106-105	-0.628	-0.114	-0.514		
105-104	-0.670	-0.208	-0.462		
104-103	-1.364	-0.677	-0.687		
103-102	1.729	0.802	0.928		
102-101	0.371	0.267	0.104		
101-100	-3.310	-1.802	-1.508		
100-099	1.277	0.592	0.685		
099-098	0.789	0.051	0.738		
098-097	-0.827	-0.615	-0.212		
097-096	-3.672	-0.883	-2.789		
096-095	-0.101	-0.199	0.099		
095-094	-2.896	-1.208	-1.688		
094-093	11.643	4.878	6.765		
093-092	-6.670	-2.972	-3.698		
092-091	-12.418	-4.357	-8.061		
091-090	12.196	4.568	7.628		
090-089	6.111	1.504	4.607		
089-088	7.804	3.638	4.166		
088-087					
087-086					
Total	-1.161				

Salt Transport 28° 15.0'S

Station Pair	Deep/ Bottom Total	6	7	8	9
185-184					
184-183					
183-182	239.030	239.030			
182-181	318.244	62.999	70.360		184.885
181-180	137.609	36.023	53.895		47.691
180-179	-127.491	-12.711	-28.955		-85.825
179-178	215.173	67.849	64.242		83.081
178-177	-68.977	-68.977			
177-176	25.101	25.101			
176-175	-26.785	-26.785			
175-174					
174-173					
173-172					
172-171					
171-170					
170-169	-239.842	-239.842			
169-168	-142.484	-142.484			
168-167					
167-166					
166-165	75.159	75.159			
165-164	175.249	175.249			
164-163	-186.190	-186.190			
163-162	173.856	173.856			
162-161	109.826	109.826			
161-160	-258.680	-258.680			
160-159	73.860	73.860			
159-158	-257.401	-188.577	-68.825		
158-157	-150.082	-150.082			
157-156					
156-155					
155-154					
154-153					
153-152					
152-151	123.159	71.650	51.509		
151-150	328.723	37.279	89.721		201.723
150-149	193.382	-27.871	-6.814	200.846	27.221
149-148	818.291	227.476	113.631	372.827	104.357
148-147	-711.262	-210.385	-228.097		-273.145
147-146	-8.530	4.526	-9.992		-3.064
146-145	-27.255	-29.771	-2.883	-12.052	17.450
145-144	464.597	104.193	119.776	153.882	86.746
144-143	-257.494	-84.515	-99.312	-39.093	-34.574
143-142	18.696	-21.398	-3.235	31.669	11.661
142-141	387.501	98.100	103.100	133.472	52.830
141-140	-210.515	-98.122	-116.296	6.618	-2.715
140-139	-853.450	-169.417	-286.561	-397.472	
139-138	-95.953	-36.893	-36.089	-22.971	
138-137	40.595	17.689	13.601	9.305	

Station Pair	Deep/ Bottom Total	6	7	8	9
137-136	194.610	34.599	49.211	110.800	
136-135	-228.902	-42.094	-74.055	-112.754	
135-134	-122.107	-13.542	-75.409	-18.198	-14.958
134-133	-200.495	-59.156	-73.225		-68.114
133-132	167.813	34.304	83.345		50.163
132-131	-454.757	-134.788	-229.866	-51.949	-38.155
131-130	182.421	58.072	82.736	23.697	17.916
130-129	80.810	47.976	32.834		
129-128	-53.662	-34.958	-18.703		
128-127	-26.177	4.411	-30.588		
127-126	-79.082	-66.632	-12.450		
126-125	283.958	93.972	189.987		
125-124	-248.739	-70.645	-178.094		
124-123	19.987	4.249	15.739		
123-122	49.745	16.879	32.866		
122-121	65.108	20.189	44.919		
121-120	-195.876	-68.557	-127.319		
120-119	124.229	42.855	81.374		
119-118	101.363	43.863	57.500		
118-117	-70.684	-31.805	-38.879		
117-116	-156.379	-86.912	-69.467		
116-115	86.306	37.947	48.359		
115-114	-136.342	-76.270	-60.073		
114-113	-35.617	-35.617			
113-112	4.832	4.832			
112-111	68.560	46.521	22.039		
111-110	-181.709	-181.709			
110-109	66.937	66.937			
109-108	-59.356	-59.356			
108-107	-14.051	-1.046	-13.005		
107-106	109.032	41.046	67.986		
106-105	-21.779	-3.952	-17.827		
105-104	-23.236	-7.209	-16.027		
104-103	-47.278	-23.463	-23.815		
103-102	59.943	27.769	32.174		
102-101	12.841	9.234	3.608		
101-100	-114.719	-62.417	-52.301		
100-099	44.264	20.497	23.767		
099-098	27.369	1.757	25.612		
098-097	-28.640	-21.304	-7.336		
097-096	-127.325	-30.591	-96.735		
096-095	-3.479	-6.905	3.426		
095-094	-10.421	-41.860	-58.561		
094-093	403.729	169.027	234.703		
093-092	-231.256	-102.974	-128.282		
092-091	-430.559	-150.965	-279.594		
091-090	422.898	158.290	264.608		
090-089	211.917	52.100	159.816		
089-088	270.538	126.065	144.473		
088-087					
087-086					
Total	-38.10				

Heat Transport 28° 15.0'S

Station Pair	Deep/ Bottom Total	6	7	8	9
185-184					
184-183					
183-182	1896.185	1896.185			
182-181	2516.485	499.619	556.537		1460.329
181-180	1089.193	285.808	426.439		376.945
180-179	-1008.104	-100.834	-229.124		-678.146
179-178	1703.581	538.513	508.338		656.729
178-177	-548.469	-548.469			
177-176	199.612	199.612			
176-175	-212.584	-212.584			
175-174					
174-173					
173-172					
172-171					
171-170					
170-169	-1903.480	-1903.480			
169-168	-1130.584	-1130.584			
168-167					
167-166					
166-165	596.999	596.999			
165-164	1391.913	1391.913			
164-163	-1480.598	-1480.598			
163-162	1382.610	1382.610			
162-161	871.637	871.637			
161-160	-2052.181	-2052.181			
160-159	586.085	586.085			
159-158	-2042.877	-1497.168	-545.709		
158-157	-1191.515	-1191.515			
157-156					
156-155					
155-154					
154-153					
153-152					
152-151	976.953	568.955	407.998		
151-150	2599.808	296.123	710.059		1593.627
150-149	1525.971	-221.479	-54.031	1586.402	215.080
149-148	6476.836	1806.919	899.727	2945.276	824.917
148-147	-5638.027	-1671.904	-1806.719		-2159.408
147-146	-67.325	36.019	-79.124		-24.220
146-145	-216.736	-236.526	-22.898	-95.188	137.876
145-144	3676.781	827.863	948.551	1215.387	684.980
144-143	-2040.084	-671.386	-786.677	-308.776	-273.244
143-142	146.594	-170.045	-25.685	250.156	92.167
142-141	3068.235	779.411	816.825	1054.373	417.626
141-140	-1670.021	-779.534	-921.308	52.283	-21.462
140-139	-6755.918	-1345.923	-2269.410	-3140.589	
139-138	-760.498	-293.030	-285.874	-181.594	
138-137	321.826	140.527	107.734	73.566	

Station Pair	Deep/ Bottom Total	6	7	8	9
137-136	1540.247	274.765	389.809	875.673	
136-135	-1812.118	-334.243	-586.627	-891.247	
135-134	-967.218	-107.576	-597.405	-143.899	-118.339
134-133	-1589.171	-469.864	-580.233		-539.074
133-132	1329.830	272.423	660.457		396.950
132-131	-3605.163	-1071.137	-1821.249	-410.902	-301.875
131-130	1446.225	461.429	655.524	187.488	141.784
130-129	641.569	381.285	260.284		
129-128	-426.198	-277.936	-148.262		
128-127	-207.185	35.113	-242.299		
127-126	-628.447	-529.621	-98.825		
126-125	2251.876	746.694	1505.181		
125-124	-1972.116	-561.273	-1410.843		
124-123	158.409	33.774	124.635		
123-122	394.485	134.088	260.397		
122-121	516.306	160.419	355.887		
121-120	-1553.504	-544.576	-1008.928		
120-119	985.250	340.395	644.855		
119-118	804.246	348.500	455.747		
118-117	-560.870	-252.698	-308.172		
117-116	-1241.326	-690.633	-550.693		
116-115	684.906	301.534	383.373		
115-114	-1082.375	-606.038	-476.337		
114-113	-282.955	-282.955			
113-112	38.422	38.422			
112-111	544.278	369.463	174.815		
111-110	-1442.935	-1442.935			
110-109	531.512	531.512			
109-108	-471.042	-471.042			
108-107	-111.401	-8.268	-103.133		
107-106	865.099	325.927	539.172		
106-105	-172.735	-31.359	-141.377		
105-104	-184.392	-57.307	-127.086		
104-103	-375.238	-186.393	-188.845		
103-102	475.648	220.533	255.117		
102-101	101.970	73.364	28.606		
101-100	-910.525	-495.846	-414.679		
100-099	351.199	162.756	188.443		
099-098	216.927	13.914	203.012		
098-097	-227.486	-169.272	-58.213		
097-096	-1009.742	-243.057	-766.685		
096-095	-27.700	-54.828	27.128		
095-094	-796.449	-332.406	-464.042		
094-093	3201.949	1342.333	1859.616		
093-092	-1834.374	-817.910	-1016.464		
092-091	-3415.600	-1199.580	-2216.020		
091-090	3353.873	1256.951	2096.922		
090-089	1680.293	413.891	1266.401		
089-088	2143.952	999.905	1144.047		
088-087					
Total	-338.492				

Mass Transport 43° 15.0'S

Station Pair	Upper Total	1	2	3	4	Unknown
001-002	0.248				0.014	0.234
002-003	-3.281			-0.331	-2.522	-0.428
003-004	-3.813				-2.983	-0.830
004-005	8.227				6.661	1.567
005-006	-1.921			-0.696	-1.225	
006-007	0.336			0.105	0.231	
007-008	1.093			0.670	0.423	
008-009	-0.659			-0.345	-0.314	
009-010	-0.557			-0.464	-0.093	
010-011	-3.413			-1.432	-1.640	-0.341
011-012	3.870			1.130	2.405	0.334
012-013	-0.446			-0.177	-0.259	-0.010
013-014	0.458			0.194	0.203	0.061
014-015	-0.048			-0.063	0.015	
015-016	-0.533			-0.045	-0.298	-0.189
016-017	0.488			0.337	0.019	0.133
017-018	-0.549			-0.356	-0.042	-0.151
018-019	0.584			0.547	0.037	
019-020	0.036			0.036		
020-021	0.116			0.069		0.042
021-022	-0.657			-0.413	-0.030	-0.214
022-023	-0.042			-0.104	-0.032	0.084
023-024	0.132			0.131	0.025	-0.024
024-025	-0.194			-0.121	-0.074	0.001
025-026	-1.012			-0.451	-0.424	-0.136
026-027	1.428			0.822	0.346	0.260
027-028	0.553			0.279	0.231	0.043
028-029	-0.134			-0.067	-0.067	
029-030	0.730			0.473	0.257	
030-031	-0.488			-0.263	-0.146	-0.079
031-032	-0.275			-0.154	-0.121	
032-033	-0.789			-0.605	-0.185	
033-034	0.811			0.633	0.178	
034-035	0.232			0.232		
035-036	0.151			0.151		
036-037	0.069			0.069		
037-038	0.121			0.121		
038-039	0.440			0.440		
039-040	-0.394			-0.394		
040-041	0.430			0.430		
041-042	-0.161			-0.161		
042-043	0.101			0.101		
043-044	0.331			0.331		
044-045	-0.069			-0.069		
045-046	0.432			0.432		
046-047	-0.598			-0.598		
047-048	-0.073			-0.073		
048-049	0.372			0.372		

Station Pair	Upper Total	1	2	3	4	Unknown
049-050	0.149			0.149		
050-051	0.193			0.193		
051-052	-0.249			-0.249		
052-053	0.671			0.671		
053-054	0.462			0.462		
054-055	-0.841			-0.841		
055-056	0.775			0.775		
056-057	-0.138			-0.138		
057-058	-0.314			-0.314		
058-059	-0.208			-0.208		
059-060	0.272			0.272		
060-061	0.430			0.430		
061-062	-0.069			-0.069		
062-063	0.453			0.453		
063-064	0.287			0.287		
064-065	0.290			0.290		
065-066	0.035			0.035		
066-067	-0.132			-0.132		
067-068	-0.019			-0.019		
068-069	0.510			0.510		
069-070	-0.316			-0.316		
070-071	-0.614			-0.614		
071-072	-0.039			-0.039		
072-073	0.562			0.562		
073-074	-0.452			-0.452		
074-075	-0.235			-0.191	-0.043	
075-076	0.025			-0.027	0.051	
076-077	-0.058			0.000	-0.059	
077-078	0.021			-0.006	0.027	
Total	3.128					

Salt Transport 43° 15.0'S

Station Pair	Upper Total	1	2	3	4	Unknown
001-002	8.772				0.490	8.282
002-003	-114.684			-11.587	-87.945	-15.151
003-004	-133.689				-104.316	-29.383
004-005	288.554				233.152	55.402
005-006	-66.955			-24.396	-42.559	
006-007	11.676			3.679	7.998	
007-008	38.083			23.415	14.669	
008-009	-22.939			-12.040	-10.899	
009-010	-19.446			-16.210	-3.236	
010-011	-119.026			-50.108	-57.008	-11.910
011-012	135.073			39.615	83.767	11.691
012-013	-15.548			-6.203	-8.997	-0.348
013-014	15.936			-6.781	7.032	2.123
014-015	-1.685			-2.202	0.517	
015-016	-18.646			-1.571	-10.483	-6.592
016-017	17.055			11.793	0.648	4.615
017-018	-19.154			-12.444	-1.468	-5.242
018-019	20.344			19.078	1.266	
019-020	1.260			1.260		
020-021	3.860			2.399		1.461
021-022	-22.845			-14.364	-1.026	-7.456
022-023	-1.444			-3.609	-1.129	3.293
023-024	4.602			4.566	-0.877	-0.842
024-025	-6.750			-4.212	-2.569	0.032
025-026	-35.287			-15.792	-14.725	-4.770
026-027	49.750			28.664	12.014	9.071
027-028	19.187			9.697	8.002	1.487
028-029	-4.652			-2.325	-2.326	
029-030	25.334			16.449	8.885	
030-031	-16.937			-9.138	-5.037	-2.763
031-032	-9.529			-5.331	-4.198	
032-033	-27.381			-20.986	-6.396	
033-034	28.094			21.946	6.148	
034-035	8.024			8.024		
035-036	5.209			5.209		
036-037	2.391			2.391		
037-038	4.181			4.181		
038-039	15.159			15.159		
039-040	-13.572			-13.572		
040-041	14.819			14.819		
041-042	-5.547			-5.547		
042-043	3.486			3.486		
043-044	11.402			11.402		
044-045	-2.384			-2.384		
045-046	14.850			14.850		
046-047	-20.552			-20.552		
047-048	-2.494			-2.494		
048-049	12.771			12.771		

Station Pair	Upper Total	1	2	3	4	Unknown
049-050	5.112			5.112		
050-051	6.630			6.630		
051-052	-8.538			-8.538		
052-053	22.980			22.980		
053-054	15.835			15.835		
054-055	-28.801			-28.801		
055-056	26.508			26.508		
056-057	-4.713			-4.713		
057-058	-10.744			-10.744		
058-059	-7.091			-7.091		
059-060	9.288			9.288		
060-061	14.654			14.654		
061-062	-2.336			-2.336		
062-063	15.438			15.438		
063-064	9.809			9.809		
064-065	9.893			9.893		
065-066	1.220			1.220		
066-067	-4.509			4.509		
067-068	-0.625			0.625		
068-069	17.339			17.339		
069-070	-10.740			-10.740		
070-071	-20.881			-20.881		
071-072	-1.316			-1.316		
072-073	19.101			19.101		
073-074	-15.340			-15.340		
074-075	-7.967			-6.510		1.457
075-076	0.798			-0.926		1.724
076-077	-1.945			0.030		-1.975
077-078	0.687			-0.227		0.914
Total	108.452					

Heat Transport 43° 15.0'S

Station Pair	Upper Total	1	2	3	4	Unknown
001-002	71.664				3.984	67.680
002-003	-932.820				-714.964	-123.775
003-004	-1087.272				-847.584	-239.688
004-005	2345.615				1893.429	452.187
005-006	-544.725			-198.571	-346.153	
006-007	94.955			29.851	65.104	
007-008	310.611			191.225	119.386	
008-009	-186.937			-98.262	-88.675	
009-010	-158.889			-132.563	-26.325	
010-011	-970.212	-98.086		-408.330	-463.797	-98.086
011-012	1100.436	-96.342		322.755	681.338	96.343
012-013	-126.594	-2.874		-50.507	-73.213	-2.874
013-014	130.071	17.582		55.263	57.227	17.582
014-015	-13.650			-17.861	4.211	
015-016	-152.733	-54.627		-12.763	-85.343	-54.627
016-017	139.771	38.303		96.197	5.271	38.303
017-018	-157.112	-43.383		-101.750	-11.969	-43.393
018-019	166.915			156.589	10.326	
019-020	10.301			10.301		
020-021	31.804	12.126		19.678		12.126
021-022	-187.893	-61.840		-117.697	-8.356	-61.840
022-023	-11.388	27.209		-29.402	-9.195	27.209
023-024	37.444	-6.933		37.234	7.144	-6.933
024-025	-55.003	0.260		-34.341	-20.922	0.260
025-026	-288.061	-39.289		-128.872	-119.900	-39.289
026-027	406.792	74.883		234.072	97.838	74.883
027-028	156.643	12.322		79.161	65.161	12.322
028-029	-37.798			-18.851	-18.947	
029-030	206.969			134.613	72.356	
030-031	-138.520			-74.629	-41.018	-22.872
031-032	-77.792			-43.596	-34.196	
032-033	-224.162			-172.071	-52.091	
033-034	230.121			180.041	50.080	
034-035	65.720			65.720		
035-036	43.092			43.092		
036-037	19.297			19.287		
037-038	34.448			34.448		
038-039	124.565			124.565		
039-040	-111.860			-111.860		
040-041	122.110			122.110		
041-042	-45.707			-45.707		
042-043	28.929			28.929		
043-044	93.442			93.442		
044-045	-19.429			-19.429		
045-046	122.009			122.009		
046-047	-169.482			-169.482		
047-048	-20.643			-20.643		
048-049	105.489			105.489		

Station Pair	Upper Total	1	2	3	4	Unknown
049-050	41.982			41.982		
050-051	54.848			54.848		
051-052	-71.170			-71.170		
052-053	190.263			190.263		
053-054	130.556			130.556		
054-055	-238.046			-238.046		
055-056	219.013			219.013		
056-057	-38.878			-38.878		
057-058	-88.853			-88.853		
058-059	-58.830			-58.830		
059-060	76.588			76.588		
060-061	121.595			121.595		
061-062	-19.544			-19.544		
062-063	128.080			128.080		
063-064	80.911			80.911		
064-065	82.182			82.182		
065-066	9.183			9.183		
066-067	-37.292			-37.292		
067-068	-5.834			-5.834		
068-069	144.629			144.629		
069-070	-89.659			-89.659		
070-071	-174.049			-174.049		
071-072	-11.074			-11.074		
072-073	159.270			159.270		
073-074	-128.323			-128.323		
074-075	-66.385			-53.957		-12.427
075-076	7.217			-7.489		14.707
076-077	-16.803			0.037		-16.840
077-078	6.026			-1.781		7.807
Total	888.124					

Mass Transport 43° 15.0'S

Station Pair	Intermediate Total	5
001-002		
002-003	1.442	1.442
003-004	-0.155	-0.155
004-005	0.865	0.865
005-006	-0.864	-0.864
006-007	0.091	0.091
007-008	0.114	0.114
008-009	-0.104	-0.104
009-010	-0.419	-0.419
010-011	-0.308	-0.308
011-012	0.582	0.582
012-013	-0.284	-0.284
013-014	0.505	0.505
014-015	0.073	0.073
015-016		
016-017		
017-018		
018-019		
019-020		
020-021		
021-022		
022-023		
023-024		
024-025		
025-026	-0.613	-0.613
026-027	0.303	0.303
027-028	0.717	0.717
028-029	0.302	0.302
029-030	0.041	0.041
030-031	-0.258	-0.258
031-032	-0.454	-0.454
032-033	-0.137	-0.137
033-034	-0.095	-0.095
034-035	0.791	0.791
035-036	-0.476	-0.476
036-037	0.394	0.394
037-038	0.053	0.053
038-039	0.271	0.271
039-040	0.158	0.158
040-041	-0.187	-0.187
041-042	-0.155	-0.155
042-043	-0.038	-0.038
043-044	0.661	0.661
044-045	-0.206	-0.206
045-046	0.485	0.485
046-047	-0.488	-0.488
047-048	0.131	0.131
048-049	0.288	0.288
049-050	0.032	0.032

Station Pair	Intermediate Total	5
050-051	0.217	0.217
051-052	0.930	0.930
052-053	-0.028	-0.028
053-054	0.438	0.438
054-055	-0.838	-0.838
055-056	0.968	0.968
056-057	-0.252	-0.252
057-058	-0.127	-0.127
058-059	-0.321	-0.321
059-060	0.780	0.780
060-061	0.465	0.465
061-062	-0.154	-0.154
062-063	0.516	0.516
063-064	0.654	0.654
064-065	-0.232	-0.232
065-066	0.680	0.680
066-067	-0.183	-0.183
067-068	1.901	1.901
068-069	-1.017	-1.017
069-070	-0.062	-0.062
070-071	-0.387	-0.376
071-072	-0.165	-0.165
072-073	0.952	0.952
073-074	-0.011	-0.011
074-075	-0.497	-0.497
075-076	-0.081	-0.081
076-077	0.363	0.363
077-078		
Total	7.771	

Salt Transport 43° 15.0'S

Station Pair	Intermediate Total	5
001-002		
002-003	50.029	50.029
003-004	-5.302	-5.302
004-005	29.689	29.689
005-006	-29.686	-29.686
006-007	3.092	3.092
007-008	3.862	3.862
008-009	-3.508	-3.508
009-010	-14.480	-14.480
010-011	-10.584	-10.584
011-012	20.028	20.028
012-013	-9.782	-9.782
013-014	17.419	17.419
014-015	2.514	2.514
015-016		
016-017		
017-018		
018-019		
019-020		
020-021		
021-022		
022-023		
023-024		
024-025	0.004	0.004
025-026	-21.162	-21.162
026-027	10.448	10.448
027-028	24.719	24.719
028-029	10.436	10.436
029-030	1.335	1.335
030-031	-8.894	-8.894
031-032	-15.589	-15.589
032-033	-4.639	-4.639
033-034	-3.352	-3.352
034-035	27.271	27.271
035-036	-16.459	-16.459
036-037	13.555	13.555
037-038	1.815	1.815
038-039	9.245	9.245
039-040	5.530	5.530
040-041	-6.522	-6.522
041-042	-1.840	-1.840
042-043	-1.313	-1.313
043-044	22.680	22.680
044-045	-7.049	-7.049
045-046	16.599	16.599
046-047	-16.718	-16.718
047-048	4.550	4.550
048-049	9.893	9.893
049-050	1.016	1.016

Station Pair	Intermediate Total	5
050-051	7.442	7.442
051-052	32.048	32.048
052-053	-1.051	-1.051
053-054	15.000	15.000
054-055	-28.686	-28.686
055-056	33.123	33.123
056-057	-8.591	-8.591
057-058	-4.309	-4.309
058-059	-11.016	-11.016
059-060	26.790	26.790
060-061	15.835	15.835
061-062	-5.237	-5.237
062-063	17.646	17.646
063-064	22.400	22.400
064-065	-4.623	-4.623
065-066	23.262	23.262
066-067	-6.243	-6.243
067-068	65.189	65.189
068-069	-35.031	-35.031
069-070	-2.083	-2.083
070-071	-12.879	-12.879
071-072	-5.699	-5.699
072-073	32.613	32.613
073-074	-0.382	-0.382
074-075	-17.043	-17.043
075-076	-2.760	-2.760
076-077	12.481	12.481
077-078		
Total	267.046	

Heat Transport 43° 15.0'S

Station Pair	Intermediate Total	5
001-002		
002-003	389.663	389.663
003-004	-47.113	-47.113
004-005	253.564	253.564
005-006	-247.554	-247.554
006-007	27.281	27.281
007-008	33.843	33.843
008-009	-31.617	-31.617
009-010	-116.469	-116.469
010-011	-88.535	-88.535
011-012	165.800	165.800
012-013	-80.009	-80.009
013-014	141.211	141.211
014-015	20.415	20.415
015-016		
016-017		
017-018		
018-019		
019-020		
020-021		
021-022		
022-023		
023-024		
024-025	0.036	0.036
025-026	-171.659	-171.659
026-027	84.928	84.928
027-028	199.804	199.804
028-029	83.462	83.462
029-030	14.062	14.062
030-031	-72.562	-72.562
031-032	-129.096	-129.096
032-033	-41.556	-41.556
033-034	-23.244	-23.244
034-035	220.943	220.943
035-036	-131.512	-131.512
036-037	110.185	110.185
037-038	15.136	15.136
038-039	78.302	78.302
039-040	42.093	42.093
040-041	-49.786	-49.786
041-042	-16.304	-16.304
042-043	-10.298	-10.298
043-044	185.570	185.570
044-045	-58.030	-58.030
045-046	137.060	137.060
046-047	-137.110	-137.110
047-048	36.133	36.133
048-049	80.490	80.890
049-050	10.510	10.510

Station Pair	Intermediate Total	5
050-051	60.642	60.642
051-052	257.513	257.513
052-053	-5.802	-5.802
053-054	122.895	122.895
054-055	-234.712	-234.712
055-056	271.226	271.266
056-057	-70.603	-70.603
057-058	-36.036	-36.036
058-059	-89.106	-89.106
059-060	217.004	217.004
060-061	130.578	130.578
061-062	-43.352	-43.352
062-063	144.362	144.362
063-064	182.507	182.507
064-065	-35.930	-35.930
065-066	189.470	189.470
066-067	-50.863	-50.863
067-068	527.735	527.735
068-069	-281.222	-281.222
069-070	-17.673	-17.673
070-071	-104.921	-104.921
071-072	-45.716	-45.716
072-073	264.941	264.941
073-074	-3.209	-3.209
074-075	-138.545	-138.545
075-076	-22.736	-22.736
076-077	100.882	100.882
077-078		
Total	2166.966	

Mass Transport 43° 15.0'S

Station Pair	Deep/ Bottom Total	6	7	8	9
001-002					
002-003					
003-004	2.918	1.972	0.946		
004-005	-7.541	-7.541			
005-006	7.319	7.319			
006-007	-4.738	-1.632	-1.115	-1.000	-0.991
007-008	-6.659	-1.685	-1.340	-2.881	-0.752
008-009	5.178	1.142	1.481	2.064	0.481
009-010	-0.020	-0.241	-0.137	0.373	-0.015
010-011	4.918	1.019	1.039	1.872	0.989
011-012	-3.165	-0.990	-0.786	-0.250	-1.139
012-013	-0.206	0.158	0.038	-0.234	-0.169
013-014					
014-015					
015-016					
016-017					
017-018					
018-019					
019-020					
020-021					
021-022					
022-023					
023-024					
024-025					
025-026					
026-027					
027-028	0.171	0.171			
028-029	0.392	0.392			
029-030	-1.375	-1.375			
030-031	0.711	0.711			
031-032	5.073	0.943	0.974		3.157
032-033	7.862	2.065	1.217	3.178	1.403
033-034	-5.850	-1.860	-0.977	-1.985	-1.028
034-035	5.882	0.823	0.956	2.785	1.318
035-036	2.332	-0.349	0.324	1.755	0.603
036-037	0.993	-0.157	0.239	0.545	0.366
037-038	-3.300	-0.719	-1.092	-0.734	-0.755
038-039	-2.991	-1.259	-0.777	-0.506	-0.449
039-040	0.991	0.482	0.077	0.276	0.156
040-041	-6.189	-2.024	-1.463	-2.181	-0.521
041-042	0.762	0.361	0.121	0.279	
042-043	0.800	0.123	0.291	0.386	
043-044	-2.556	-0.626	-0.800	-1.130	
044-045	-7.312	0.001	-2.908	-4.405	
045-046	0.482	-1.039	-0.334	1.855	
046-047	6.771	1.027	1.504	4.240	
047-048	-0.847	0.121	-0.486	-0.482	
048-049	0.109	-0.067	-0.096	0.272	

Station Pair	Deep/ Bottom Total	6	7	8	9
049-050	-6.022	-1.239	-2.864	-1.918	
050-051	0.457	0.031	0.184	0.242	
051-052	2.877	0.906	1.390	0.581	
052-053	-4.714	-1.625	-3.089		
053-054	-2.529	-0.875	-1.654		
054-055	3.775	1.303	2.472		
055-056	-4.227	-1.959	-2.269		
056-057	1.125	1.125			
057-058	1.565	1.565			
058-059	-0.047	-0.047			
059-060	1.168	1.168			
060-061	-4.211	-1.801	-1.298	-1.112	
061-062	2.155	0.503	0.877	0.775	
062-063	-0.520	-0.372	-0.070	-0.079	
063-064	-0.102	-0.308	0.037	0.169	
064-065	-3.579	-1.132	-1.172	-1.275	
065-066	1.917	0.152	0.768	0.997	
066-067	-0.181	-0.102	-0.079		
067-068	0.583	-0.003	0.587		
068-069	-2.719	-2.719			
069-070	0.782	0.782			
070-071	0.508	0.361	0.147		
071-072	-0.039	-0.256	0.217		
072-073	-1.321	-0.562	-0.760		
073-074	0.826	0.397	0.429		
074-075	-0.908	-0.312	-0.596		
075-076	1.341	0.633	0.708		
076-077	0.287	0.287			
077-078					
Total	-10.838				

Salt Transport 43° 15.0'S

Station Pair	Deep/ Bottom Total	6	7	8	9
001-002					
002-003					
003-004	101.292	68.442	32.850		
004-005	-261.756	-261.756			
005-006	254.134	254.134			
006-007	-164.513	-56.641	-38.745	-34.700	-34.426
007-008	-231.203	-58.508	-46.551	-100.029	-26.116
008-009	179.788	39.648	51.786	71.658	16.696
009-010	-0.688	-8.358	-4.747	12.947	-0.531
010-011	170.745	35.346	36.078	64.987	34.333
011-012	-109.857	-34.334	-27.300	-8.662	-39.561
012-013	-7.170	5.490	1.328	-8.120	-5.869
013-014					
014-015					
015-016					
016-017					
017-018					
018-019					
019-020					
020-021					
021-022					
022-023					
023-024					
024-025					
025-026					
026-027					
027-028	5.936	5.936			
028-029	13.589	13.589			
029-030	-47.709	-47.709			
030-031	24.660	24.660			
031-032	176.132	32.686	33.815		109.631
032-033	272.934	71.638	42.273	110.318	48.707
033-034	-203.054	-64.533	-33.921	-68.888	-35.713
034-035	204.203	28.557	33.206	96.669	45.771
035-036	81.006	-12.097	11.252	60.919	20.931
036-037	34.504	-5.431	8.288	18.926	12.721
037-038	-114.558	-24.947	-37.934	-25.467	-26.210
038-039	-103.765	-43.648	-26.984	-17.551	-15.581
039-040	34.373	16.707	2.671	9.575	5.419
040-041	-214.759	-70.170	-50.791	-75.703	-18.095
041-042	26.417	12.511	4.214	9.692	
042-043	27.780	4.257	10.115	13.408	
043-044	-88.695	-21.689	-27.775	-39.221	
044-045	-253.798	0.041	-100.916	-152.924	
045-046	16.807	-36.000	-11.595	64.401	
046-047	-234.980	35.609	52.181	147.190	
047-048	-29.422	4.185	-16.870	-16.737	
048-049	3.780	-2.330	-3.316	9.426	

Station Pair	Deep/ Bottom Total	6	7	8	9
049-050	-208.895	-42.940	-99.370	-66.585	
050-051	15.874	1.076	6.395	8.403	
051-052	99.768	31.382	48.211	20.176	
052-053	-163.464	-56.299	-107.165		
053-054	-87.697	-30.325	-57.372		
054-055	130.914	45.172	85.741		
055-056	-146.575	-67.891	-78.684		
056-057	38.996	38.996			
057-058	54.256	54.256			
058-059	-1.625	-1.625			
059-060	40.475	40.475			
060-061	-146.113	-62.438	-45.065	-38.610	
061-062	74.760	17.449	30.426	26.886	
062-063	-18.044	-12.896	-2.416	-2.731	
063-064	-3.525	-10.665	1.282	5.858	
064-065	-124.186	-39.247	-40.689	-44.251	
065-066	66.534	5.263	26.656	34.615	
066-067	-6.268	-3.544	-2.724		
067-068	20.236	-0.119	20.354		
068-069	-94.239	-94.239			
069-070	27.102	27.102			
070-071	17.614	12.527	5.088		
071-072	-1.324	-8.858	7.534		
072-073	-45.815	-19.466	-26.349		
073-074	28.654	13.758	14.895		
074-075	-31.473	-10.803	-20.671		
075-076	46.507	21.953	24.554		
076-077	9.926	9.926			
077-078					
Total	-375.511				

Heat Transport 43° 15.0'S

Station Pair	Deep/ Bottom Total	6	7	8	9
001-002					
002-003					
003-004	802.839	542.818	260.021		
004-005	-2075.417	-2075.417			
005-006	2013.921	2013.921			
006-007	-1301.956	-449.215	-306.515	-274.125	-272.102
007-008	-1828.863	-463.850	-368.234	-790.326	-206.453
008-009	1422.347	314.528	409.727	566.115	131.977
009-010	-5.794	-66.328	-37.563	102.292	-4.195
010-011	1351.058	280.502	285.576	513.529	271.450
011-012	-869.827	-272.548	-216.105	-68.445	-312.728
012-013	-56.446	43.588	10.519	-64.163	-46.390
013-014					
014-015					
015-016					
016-017					
017-018					
018-019					
019-020					
020-021					
021-022					
022-023					
023-024					
024-025					
025-026					
026-027					
027-028	47.246	47.246			
028-029	108.033	108.033			
029-030	-378.454	-378.454			
030-031	195.516	195.516			
031-032	1393.207	259.483	267.594		866.130
032-033	2158.650	568.402	334.354	871.057	384.837
033-034	-1606.615	-512.073	-268.312	-544.031	-282.199
034-035	1614.388	266.522	262.695	763.466	361.705
035-036	639.520	-96.198	89.043	481.224	165.446
036-037	272.486	-43.145	65.570	149.525	100.537
037-038	-906.618	-198.032	-300.213	-201.215	-207.159
038-039	-821.997	-346.577	-213.586	-138.676	-123.159
039-040	272.388	132.753	21.136	75.662	42.837
040-041	-1700.459	-557.143	-402.063	-598.194	-143.059
041-042	209.363	99.392	33.381	76.590	
042-043	219.851	33.792	80.091	105.968	
043-044	-702.257	-172.351	-219.926	-309.981	
044-045	-2007.232	0.363	-798.991	-1208.604	
045-046	131.017	-286.042	-91.935	508.994	
046-047	1859.363	282.769	413.178	1163.416	
047-048	-232.583	33.314	-133.573	-132.323	
048-049	29.735	-18.507	-26.283	74.525	

Station Pair	Deep/ Bottom Total	6	7	8	9
049-050	-1654.737	-341.085	-787.111	-526.541	
050-051	125.656	8.539	50.648	66.470	
051-052	790.819	249.278	381.897	159.644	
052-053	-1296.164	-447.234	-848.930		
053-054	-695.316	-240.834	-454.482		
054-055	1038.002	358.766	679.236		
055-056	-1162.630	-539.093	-623.537		
056-057	309.491	309.491			
057-058	430.695	430.695			
058-059	-12.916	-12.916			
059-060	321.575	321.575			
060-061	-1157.760	-495.572	-356.789	-305.398	
061-062	592.057	138.569	240.944	212.544	
062-063	-143.128	-102.411	-19.137	-21.580	
063-064	-28.238	-84.713	10.148	46.327	
064-065	-983.341	-311.601	-322.104	-349.636	
065-066	526.160	41.713	211.012	273.436	
066-067	-49.713	-28.134	-21.579		
067-068	160.215	-0.955	161.170		
068-069	-748.361	-748.361			
069-070	215.251	215.251			
070-071	139.785	99.450	40.335		
071-072	-10.704	-70.427	59.723		
072-073	-363.380	-154.505	-208.875		
073-074	227.270	109.189	118.080		
074-075	-249.677	-85.795	-163.882		
075-076	368.917	174.278	194.639		
076-077	79.033	79.033			
077-078					
Total	-2984.729				

APPENDIX C

GEOSTROPHIC POINT DEPTH CURRENT VELOCITIES
Latitude 28° 15.0'S

Station Pair	185/184	184/183	183/182	182/181	181/180
Depth(m)		Units	cm/sec		
0	-11.7	-84.1	-20.6	52.8	-19.5
100	0.0	-70.0	-19.9	40.2	-14.9
250		-34.3	-11.3	14.3	-7.4
500		-8.3	-1.8	2.8	-2.0
762		0.0	0.0	0.0	0.0
1000		4.7	1.0	0.5	-0.03
2000			13.0	5.0	1.9
2500				7.4	4.2
3000				8.4	6.3
3500				8.3	8.0
4000				8.3	8.6
5000					

	180/179	179/178	178/177	177/176
0	-2.3	-17.4	5.5	-0.2
100	-5.7	-16.6	4.9	-0.4
250	-2.5	-10.5	2.4	0.3
500	-1.0	-2.6	1.2	-0.4
762	0.0	0.0	0.0	0.0
1000	-0.3	2.4	-1.0	0.4
2000	-0.6	5.0	-4.2	
2500	-1.6	5.4		
3000	-2.9	6.1		
3500	-3.0			
4000	-2.1			
5000				

Units cm/sec

Depth (m)	176/175	175/174	174/173	173/172	172/171	171/170	170/169	169/168	168/167	167/166
0	6.5	2.6	6.3	-1.7	-2.4	-4.4	3.0	4.4	18.1	-1.05
100	4.9	4.3	5.9	0.2	-2.9	-5.7	2.8	4.7	14.2	-1.18
250	3.1	2.7	3.8	0.7	-4.2	-5.4	3.5	3.3	8.6	-0.5
500	0.33	0.9	1.2	3.4	-3.5	-2.7	0.8	1.2	1.0	0.51
762	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1000	-0.19	-0.14	-0.8	-3.0	2.8	2.0	-0.5	-0.6		
2000	-0.58						-4.6	-2.4		
2500							-4.9	-2.8		
3000							-5.1	-3.1		
3500										
4000										
5000										

Units cm/sec

Depth (m)	166/165	165/164	164/163	163/162	162/161	161/160	160/159	159/158	158/157	157/156
0	-10.5	-6.8	13.1	-6.3	-9.4	2.7	3.7	12.2	-2.7	-14.9
100	-7.5	-5.9	10.1	-4.4	-7.7	2.5	2.4	9.6	-0.7	-11.7
250	-4.0	-5.6	7.9	-3.7	-5.9	2.9	0.8	6.1	-0.4	-5.5
500	-1.1	-2.4	3.1	-1.6	-1.7	1.3	-0.1	1.8	1.2	-3.1
762	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1000	1.4	1.2	-2.8	2.1	0.7	-0.6	0.2	-1.5	-2.2	
2000	2.8	4.3	-6.2	3.7	1.4	-2.9	0.9	-4.5	-3.9	
2500					2.1	-3.2	1.1	-5.2	-3.3	
3000					2.4	-3.8	1.1	-5.4	-2.9	
3500					2.6	-4.2	1.1			
4000						-4.2				
5000										

Units cm/sec

Depth (m)	156/155	155/154	154/153	153/152	152/151	151/150	150/149	149/148	148/147	147/146
0	15.5	14.8	-6.0	-3.6	-1.2	-11.7	-7.3	-12.1	20.9	2.4
100	11.1	10.4	1.5	-3.8	0.2	-7.6	-6.9	-9.1	14.0	1.8
250	5.1	5.8	2.6	-1.2	-0.7	-2.3	-4.3	-5.4	6.8	1.5
500	1.9	2.2	-0.3	-0.4	0.3	2.9	-3.5	-2.1	1.4	0.7
762	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1000				-0.5	-0.3	1.3	0.3	1.0	-0.6	-0.6
2000					2.8	3.3	-2.7	5.1	-6.9	0.4
2500					4.6	4.5	-2.8	6.1	-8.6	0.0
3000					4.9	9.1	-1.4	6.7	-9.6	-0.4
3500						17.1	0.9	6.2	-10.1	-0.5
4000						20.2	3.8	5.7		
5000							7.5	5.3		

Units cm/sec

Depth (m)	146/145	145/144	144/143	143/142	142/141	141/140	140/139	139/138	138/137	137/136
0	-0.9	-7.7	5.4	-1.1	-8.3	3.0	8.2	-2.2	0.7	-3.7
100	0.3	-6.9	4.3	-0.9	-6.2	2.4	7.0	-1.4	-0.1	-1.9
250	0.4	-3.7	2.9	-0.6	-3.2	1.5	3.8	0.0	-0.1	-1.2
500	0.5	-0.6	0.5	-0.3	-0.5	0.5	0.9	0.4	-0.3	0.1
762	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1000	-0.2	0.4	0.0	-0.1	0.2	-0.3	-0.5	-0.3	0.2	0.1
2000	-0.5	2.2	-1.5	-0.6	1.6	-1.5	-2.3	-0.5	0.3	0.5
2500	-0.7	2.4	-2.0	-0.3	1.7	-1.7	-2.6	-0.6	0.2	0.6
3000	-0.2	2.4	-2.2	-0.2	1.7	-1.7	-3.1	-0.5	0.2	0.6
3500	0.4	2.6	-1.8	0.1	1.6	-1.5	-3.4	-0.6	0.2	0.8
4000	0.4	3.6	-1.4	0.5	1.7	-0.4	-4.7	-0.4	0.2	1.2
5000				0.7	2.1	0.1	-5.2			1.3

Units cm/sec

Depth (m)	136/135	135/134	134/133	133/132	132/131	131/130	130/129	129/128	128/127	127/126
0	6.6	1.6	-2.3	-2.3	-0.7	-3.0	-4.3	-2.2	9.1	-1.5
100	5.1	1.4	-0.6	-1.5	0.3	-1.9	-4.5	-1.2	6.9	0.1
250	2.5	0.9	0.4	-0.8	0.2	-0.1	-3.7	-0.5	4.0	0.6
500	0.0	0.4	0.3	-0.1	0.3	0.0	-0.5	-0.2	0.8	0.2
762	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1000	0.0	-0.3	0.0	-0.1	-0.6	0.3	0.3	-0.3	0.0	-0.3
2000	-0.5	-0.2	-1.2	0.5	-2.2	1.0	0.8	-0.5	0.1	-1.2
2500	-0.8	-0.4	-1.3	1.0	-2.6	1.1	0.8	-0.4	-0.1	-0.9
3000	-1.0	-1.0	-1.1	1.1	-2.8	1.0	0.7	-0.4	-0.4	-0.4
3500	-1.3	-1.1		1.3	-2.7	1.1			-0.7	0.2
4000	-1.4	-0.8			-2.1	1.1				
5000	-1.1									

	126/125	125/124	124/123	123/122	122/121	121/120	120/119	119/118	118/117	117/116
0	-5.5	-2.4	2.5	-5.5	-2.8	6.9	-6.9	4.3	-4.0	6.9
100	-4.5	-2.9	3.0	-5.8	-2.9	5.9	-6.7	4.5	-4.7	7.1
250	-2.4	-0.8	1.5	-3.3	-1.4	3.3	-3.6	2.6	-3.3	4.4
500	-0.1	0.1	0.0	-0.3	-0.2	0.7	-0.5	0.2	-0.7	1.1
762	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1000	0.4	-0.4	0.3	0.0	-0.1	-0.1	-0.6	0.8	0.2	-0.9
2000	1.8	-1.3	0.1	0.3	0.4	-1.2	0.8	0.8	-0.6	-1.5
2500	1.9	-1.6	0.0	0.4	0.4	-1.6	1.1	0.9	-0.7	-1.5
3000	1.9	-1.7	0.1	0.3	0.5	-1.8	1.2	0.9	-0.7	-1.4
3500	1.9	-1.9	0.2	0.3	0.5	-1.8	1.3			
4000	1.8	-1.8	0.4	0.4						
5000										

Units cm/sec

Depth (m)	116/115	115/114	114/113	113/112	112/111	111/110	110/109	109/108	108/107	107/106
0	-3.3	7.4	0.2	-3.2	1.1	1.6	-3.8	2.4	1.2	0.3
100	-3.6	6.7	0.4	-3.2	1.5	0.9	-3.9	2.1	0.9	-0.1
250	-1.8	4.1	0.1	-1.6	1.1	1.0	-2.8	1.5	0.6	-0.5
500	-0.3	0.5	0.0	0.0	-0.1	0.6	-0.3	0.3	0.2	-0.2
762	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1000	0.7	-0.5	-0.5	0.0	0.0	-0.8	0.1	0.1	-0.2	0.0
2000	0.6	-1.2		0.1	0.8	-2.3	0.8	-0.4	0.0	0.7
2500	0.8	-1.5			1.0	-2.4	0.9	-0.5	-0.2	1.2
3000	0.9	-1.5					0.9	-0.7	-0.3	1.4
3500										
4000										
5000										

Units cm/sec

Depth (m)	106/105	105/104	104/103	103/102	102/101	101/100	100/099	099/098	098/097	097/096
0	1.0	1.0	1.5	-2.6	3.0	1.5	0.0	2.1	-99.3	2.4
100	0.9	1.3	1.9	-3.0	3.0	1.6	0.1	2.2	143.3	2.1
250	1.0	1.2	0.9	-2.0	0.2	3.0	0.4	0.5	-206.1	1.2
500	0.3	0.2	0.0	-0.2	-1.2	1.7	0.2	-0.1	-61.0	0.3
762	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1000	-0.3	-0.1	-0.4	0.2	0.1	-0.4	-0.7	0.2	-38.9	-0.2
2000	0.0	-0.1	-0.5	0.5	0.2	-1.2	0.3	-0.1	-212.5	-0.3
2500	-0.2	-0.1	-0.4	0.6	0.2	-1.2	0.6	0.3	-258.5	-0.3
3000	-0.3	-0.3	-0.4	0.5	0.0	-0.9	0.4	0.5	-120.9	-0.5
3500	-0.4	-0.4	-0.3	0.4			-0.1			-0.7
4000										
5000										

Units cm/sec

Depth (m)	096/095	095/094	094/093	093/092	092/091	091/090	090/089	089/088	088/087	087/086
0	-1.2	2.3	0.6	10.3	15.2	-0.4	-11.5	-12.3	0.0	1.4
100	-0.6	2.1	-1.9	13.8	8.2	-1.7	-5.6	-13.9	-23.4	
250	0.2	0.7	-5.7	15.1	3.8	-1.5	-2.0	-11.6	-27.2	
500	0.0	0.6	-2.2	5.3	1.1	-0.5	-1.0	-3.4	-10.1	
762	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1000	0.2	-0.4	1.1	-2.6	-1.5	1.4	0.6	3.8		
2000	-0.1	-0.6	2.6	-4.0	-5.8	5.3	1.9	9.1		
2500	-0.1	-0.7	2.9	-4.1	-6.6	6.7	1.6	7.8		
3000	-0.1	-0.7	3.2	-4.6	-6.7	7.5	1.6	6.5		
3500	0.1	-0.9	3.2	-4.6	-5.9	7.2	2.5			
4000							3.8			
5000										

Point Depth Geostrophic Velocities
Latitude 43° 15.0'S

Units cm/sec

Station Pair	001/002	002/003	003/004	004/005	005/006
Depth(m)					
0	8.1	-14.5	-14.3	16.6	-1.0
100	11.5	-23.7	-14.1	16.4	-1.8
250		-29.7	-10.9	14.8	-3.0
500		-27.3	-7.8	12.9	-3.9
1000		-7.5	-2.5	4.3	-1.5
1203		0.0	0.0	0.0	0.0
2000			3.1	-7.2	2.9
2500			4.6	-8.4	3.7
3000			4.4		
3500					
4000					
5000					

	006/007	007/008	008/009	009/010	010/011	011/012
0	-0.4	1.9	-0.7	-1.8	-3.6	3.2
100	0.3	1.5	-0.9	-0.9	-3.9	4.0
250	0.5	1.1	-0.6	-0.6	-3.5	3.7
500	0.7	0.8	-0.9	-0.2	-2.1	2.7
1000	0.2	0.3	-0.3	0.0	-0.3	0.6
1203	0.0	0.0	0.0	-0.3	0.0	0.0
2000	-0.9	-0.9	1.0	-0.2	0.8	-0.9
2000	-1.1	-1.2	1.1	-0.1	1.1	-0.8
2500	-1.2	-1.4	1.1	0.0	1.1	-0.8
3000	-1.0	-1.7	1.0	0.2	1.0	-0.8
3500	-0.9	-1.8	1.0		0.9	-0.8
4000						
5000						

Units cm/sec

Depth (m)	012/013	013/014	014/015	015/016	016/017	017/018	018/019	019/020	020/021	021/022
0	0.0	1.6	0.9	-3.9	1.0	-5.0	3.6	-0.5	0.6	-3.1
100	-0.9	1.7	-0.7	-1.7	0.6	-4.0	2.6	0.4	0.5	-2.0
250	-1.1	1.5	-0.4	-0.5	0.2	-1.1	0.9			-0.5
500	-1.2	1.6	0.3							
1000	-0.3	0.9	0.0							
1203	0.0	0.0								
2000	0.3									
2500	0.2									
3000	-0.1									
3500	-0.6									
4000										
5000										

Depth (m)	022/023	023/024	024/025	025/026	026/027	027/028	028/029	029/030	030/031	031/032
0	1.9	-0.4	0.0	-2.9	6.1	0.8	1.2	2.3	-3.6	-0.3
100	-0.4	0.4	-0.3	-2.6	6.0	1.6	-0.7	3.2	-3.0	-1.2
250	-0.4	0.3	-0.5	-2.0	3.2	1.8	-0.8	2.9	-2.3	-2.0
500			-0.2	-1.8	1.0	1.7	0.3	2.3	-1.5	-3.1
1000				-0.4	0.5	-0.2	1.0	1.0	-0.5	-1.2
1203					0.0	0.0		0.0	0.0	0.0
2000						0.8		-2.3	0.1	2.0
2500								-2.1	1.3	2.5
3000										3.7
3500										5.3
4000										6.1
5000										

Units cm/sec

Depth (m)	032/033	033/034	034/035	035/036	036/037	037/038	038/039	039/040	040/041	041/042
0	-3.1	1.7	0.3	1.2	-0.8	0.5	1.0	-1.4	1.7	-0.6
100	-2.7	1.4	0.5	0.3	0.3	0.3	0.9	-0.8	0.8	-0.3
250	-2.1	1.0	0.5	0.0	0.4	0.1	0.8	-0.5	0.6	-0.2
500	-1.6	0.7	0.4	0.0	0.3	0.1	0.7	-0.3	0.4	-0.3
1000	-0.9	0.4	0.2	0.1	0.0	0.0	0.3	0.1	-0.1	-0.1
1203	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2000	1.7	-0.8	0.2	-0.5	-0.1	-0.2	-0.6	0.6	-1.0	0.3
2500	2.3	-1.0	0.4	-0.2	-0.1	-0.4	-0.7	0.2	-1.0	0.2
3000	2.5	-1.0	0.8	0.2	0.0	-0.6	-0.6	0.0	-1.0	0.1
3500	2.7	-1.0	1.2	0.5	0.2	-0.8	-0.5	0.1	-1.0	0.0
4000	3.2	-1.1	1.4	0.8	0.4	-0.8	-0.5	0.2	-1.1	0.1
5000								0.2	-1.2	0.2

Depth (m)	042/043	043/044	044/045	045/046	046/047	047/048	048/049	049/050	050/051	051/052
0	1.2	-0.2	0.4	0.6	-1.8	-0.2	1.1	0.1	1.0	-1.9
100	-0.1	1.0	-0.3	1.0	-1.4	-0.3	0.8	0.4	0.4	-0.7
250	0.0	0.9	-0.3	0.8	-0.7	0.0	0.4	0.4	0.2	0.4
500	0.0	0.7	-0.3	0.7	-0.6	0.0	0.3	0.3	0.2	0.3
1000	0.0	0.3	-0.1	0.2	-0.1	-0.1	0.1	0.2	0.1	-0.1
1203	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2000	0.0	-0.4	0.1	-0.7	0.5	0.2	-0.1	-0.9	0.0	0.7
2500	0.1	-0.4	-0.2	-0.8	0.6	-0.1	-0.1	-1.0	0.0	0.6
3000	0.1	-0.4	-1.4	0.0	0.7	-0.2	-0.1	-1.2	0.1	0.6
3500	0.2	-0.4	-1.6	0.1	0.8	-0.3	0.0	-1.2	0.1	0.6
4000	0.2	-0.5	-1.6	0.2	1.0	-0.3	0.2	-1.2	0.2	0.7
5000	0.1	-0.3	-1.7	0.4						

Units cm/sec

Depth (m)	052/053	053/054	054/055	055/056	056/057	057/058	058/059	059/060	060/061	061/062
0	2.5	1.2	-2.8	1.6	0.0	-0.8	-0.9	0.1	1.5	-0.7
100	1.5	1.1	-1.9	2.0	-0.5	-0.7	-0.4	0.6	0.9	0.0
250	0.5	0.7	-1.0	1.2	-0.2	-0.5	-0.2	0.7	0.6	-0.2
500	0.5	0.5	-0.9	1.0	-0.2	-0.3	-0.2	0.5	0.7	-0.2
1000	0.2	0.2	-0.4	0.5	-0.2	0.0	-0.1	0.1	0.3	-0.1
1203	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2000	-1.0	-0.5	0.8	-1.2	0.5	0.8	0.0	0.5	-0.8	0.3
2500	-1.1	-0.7	-.9	-1.5	0.6	1.0			-1.1	0.5
3000	-1.2	-0.8	1.1	-1.6					-1.4	0.6
3500	-1.2	-0.8	1.3						-1.7	0.7
4000										
5000										

Depth (m)	062/063	063/064	064/065	065/066	066/067	067/068	068/069	069/070	070/071	071/072
0	1.7	0.2	1.2	-1.0	-0.1	-0.8	2.0	-1.4	-2.5	-1.0
100	0.8	0.8	0.7	0.0	-0.4	-0.2	1.2	-0.8	-2.0	0.2
250	0.7	0.7	0.3	0.7	-0.3	0.7	0.3	-0.2	-1.0	-0.2
500	0.6	0.6	0.1	0.6	-0.2	0.9	0.0	-0.2	-0.5	-0.1
1000	0.2	0.3	0.3	0.0	-0.1	1.7	-1.4	-0.1	-0.1	0.0
1203	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2000	-0.2	-0.3	-0.6	-0.1	0.0	0.0	-1.0	0.5	0.2	-0.6
2500	-0.2	-0.2	-0.7	0.2	-0.1	0.0	-1.3	0.4	0.3	0.0
3000	-0.1	0.0	-0.8	0.4	-0.1	0.2			0.3	0.3
3500	0.0	0.4	-1.0	0.7	0.0	0.6				
4000			-1.6	0.9						
5000										

Units cm/sec

Depth (m)	072/073	073/074	074/075	075/076	076/077	077/078
0	3.7	-3.9	-1.3	2.9	-16.3	2.7
100	2.7	-2.3	-1.0	0.0	-2.7	0.3
250	2.0	-0.9	-1.4	-1.0	4.2	0.0
500	1.8	0.1	-1.0	-0.2	4.8	
1000	0.6	0.0	-0.3	-0.2	2.0	
1203	0.0	0.0	0.0	0.0		
2000	-0.3	0.2	-0.4	0.9		
2500	-1.0	0.8	-0.8	1.7		
3000	-1.4	0.7	-0.8	2.2		
3500						
4000						
5000						

APPENDIX D

END POINT DATA
Mass, Salt and Heat Transports

28°15'S
West End

Cross Sectional Area (Beach to Station 185) = 1,900,000 m^2

Cross Sectional Area (Station 185-184) = 2,707,000 m^2

Mass Transport (Station 185-184) = -0.204×10^{12} gm/sec

Salt Transport (Station 185-184) = -7.242×10^{12} ^{o}/oo/sec

Heat Transport (Station 185-184) = -59.782×10^{12} cal/sec

$$\text{Mass,Salt,Heat (Beach-S185)} = \text{Mass,Salt,Heat (S185-S184)} \times \frac{\text{Area (Beach-S185)}}{\text{Area (S185-S184)}}$$

Mass Transport (Beach-S185) $\leq -0.143 \times 10^{12}$ gm/sec

Salt Transport (Beach-S185) $\leq -5.083 \times 10^{12}$ ^{o}/oo/sec

Heat Transport (Beach-S185) $\leq -41.960 \times 10^{12}$ cal/sec

East End

Cross Sectional Area (S86-Beach) = 300,000 m^2

Cross Sectional Area (S87-S86) = 559,000 m^2

Mass Transport (S087-S086) = $.002 \times 10^{12}$ gm/sec

Salt Transport (S087-S086) = $.069 \times 10^{12}$ ^{o}/oo/sec

Heat Transport (S087-S086) = $.578 \times 10^{12}$ cal/sec

$$\text{Mass,Salt,Heat (S86-Beach)} = \text{Mass,Salt,Heat (S87-S86)} \times \frac{\text{Area (S86-Beach)}}{\text{Area (S87-S86)}}$$

Mass Transport
(S86-Beach) $\leq .001 \times 10^{12}$ gm/sec

Salt Transport
(S86-Beach) $\leq .037 \times 10^{12}$ ^{o}/oo/sec

Heat Transport
(S86-Beach) $\leq .310 \times 10^{12}$ cal/sec

$43^{o}15'$S
West End

Cross Sectional Area
(Beach-S001) = 3,000,000 m^2

Cross Sectional Area
(S001-S002) = 3,610,000 m^2

Mass Transport
(S001-S002) = 0.248×10^{12} gm/sec

Salt Transport
(S001-S002) = 8.772×10^{12} ^{o}/oo/sec

Heat Transport
(S001-S002) = 71.664×10^{12} cal/sec

$$\text{Mass,Salt,Heat (Beach-S001)} = \text{Mass,Salt,Heat (S001-S002)} \times \frac{\text{Area (Beach-S001)}}{\text{Area (S001-S002)}}$$

Mass Transport
(Beach-S001) $\leq 0.206 \times 10^{12}$ gm/sec

Salt Transport
(Beach-S001) $\leq 7.290 \times 10^{12}$ ^{o}/oo/sec

Heat Transport
(Beach-S001) $\leq 59.554 \times 10^{12}$ cal/sec

East End

Cross Sectional Area
(S078-Beach) = 7,400,000 m^2

Cross Sectional Area
(S077-S078) = 5,750,000 m^2

Mass Transport (S077-S078) $= 0.021 \times 10^{12}$ gm/sec

Salt Transport (S077-S078) $= 0.687 \times 10^{12}$ ^{o}/oo/sec

Heat Transport (S077-S078) $= 6.026 \times 10^{12}$ cal/sec

$$\text{Mass, Salt, Heat (S87-Beach)} = \text{Mass, Salt, Heat (S077-S078)} \times \frac{\text{Area (S078-Beach)}}{\text{Area (S077-S078)}}$$

Mass Transport (S078-Beach) $\leq 0.027 \times 10^{12}$ gm/sec

Salt Transport (S078-Beach) $\leq 0.884 \times 10^{12}$ ^{o}/oo/sec

Heat Transport (S078-Beach) $\leq 7.755 \times 10^{12}$ cal/sec

The end section values are assumed suspect in that the conditions of the closest station pair to the beach are assumed to continue to the shore. The transports are believed to be between 50% and 90% of the calculated values due to the unknown decrease in velocity toward the shore line which was not taken into account. These values have not been included in the overall transoceanic calculations.

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