

ESTIMATES OF VERTICAL VELOCITIES AND EDDY COEFFICIENTS IN THE BAY OF BENGAL⁺

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Vertical velocities and eddy coefficients in the intermediate depths of the Bay of Bengal are calculated from mean hydrographic data for 300 miles-squares presented in Wyrtki (1971) following methods adopted by Bennett (1970) in the Arabian Sea.

Fig. 1 shows density (σ_θ) versus log-depth plots for different zones in the Bay of Bengal. The curves are for 5 degrees-squares between longitudes as marked in the figure. The curves are strikingly linear between 400 and 1200 m and linearity is a good approximation from 300 m also. From 1200 m to 2500 m the curves show a gradual increase in slope and from 2500 m the curves are again linear. This linearity is a result of steady balance between vertical advection and turbulent mixing (Munk, 1966; Bennett, 1970) in maintaining the logarithmic profile on a mean basis. The break in slope at about 2250 m is due to penetration of the North Atlantic Deep Water into the Bay of Bengal (Bennett, 1970).

Varkey and Sastry (1989) showed that there is a net yearly mean outward transport of $166.4 \times 10^9 \text{ m}^3/\text{day}$ of water from the Bay of Bengal between surface and 1250 m. This is equal to a net outflow depth of 539.4 cm, when the full volume is evenly distributed over the Bay. Varkey (1986) showed that the net height of (E+P+R) for the Bay is 6.6 cm. Hence, the net (E+P+R) value is only 1.2% of the transport depth and can be safely neglected for studies on vertical water structure below thermocline on a mean yearly basis. This outflowing water is considered here to have uniformly ascended from depths greater than 2500 m where it reaches due to global northward movement of deep waters. Taking the area of Bay of Bengal at 2000 m level (excluding the Andaman Sea) as 1.7×10^{12} sq. metres, the mean upward velocity on 2300 m surface is 1.1×10^{-4} cm/sec. From Fig. 2, mean W/K_z value for the Bay (1750-2250 m layer), excluding the Andaman Sea, is $1.6 \times 10^{-5} \text{ cm}^{-1}$. Hence, an estimate of K_z in this layer is $7 \text{ cm}^2/\text{sec}$. Bennett (1970) got a value of $2.5 \text{ cm}^2/\text{sec}$ for the layer 1700-3000 m in the North Indian Ocean and Munk (1966) obtained $1.3 \text{ cm}^2/\text{sec}$ for deep interiors of the ocean. Assuming alternatively that this water ascends into the surface layers nonuniformly at the bottom level (2300 m), i.e., placing regions of low and high upward velocities at 2300 m level, even 25% variations ($+ 0.28 \times 10^{-4}$ cm/sec) in W would result in K_z values to vary between 8.8 and $5.3 \text{ cm}^2/\text{sec}$ only.

In the linear logarithmic zone, Bennett (1970) found that the vertical eddy coefficients (K_z) decrease linearly from 1200 to 400 m, satisfying a relation $K_z = 0.02 \times D$ (in metres). Hence, with a constant W/K_z value of 6.12×10^{-6} (from Fig. 2),

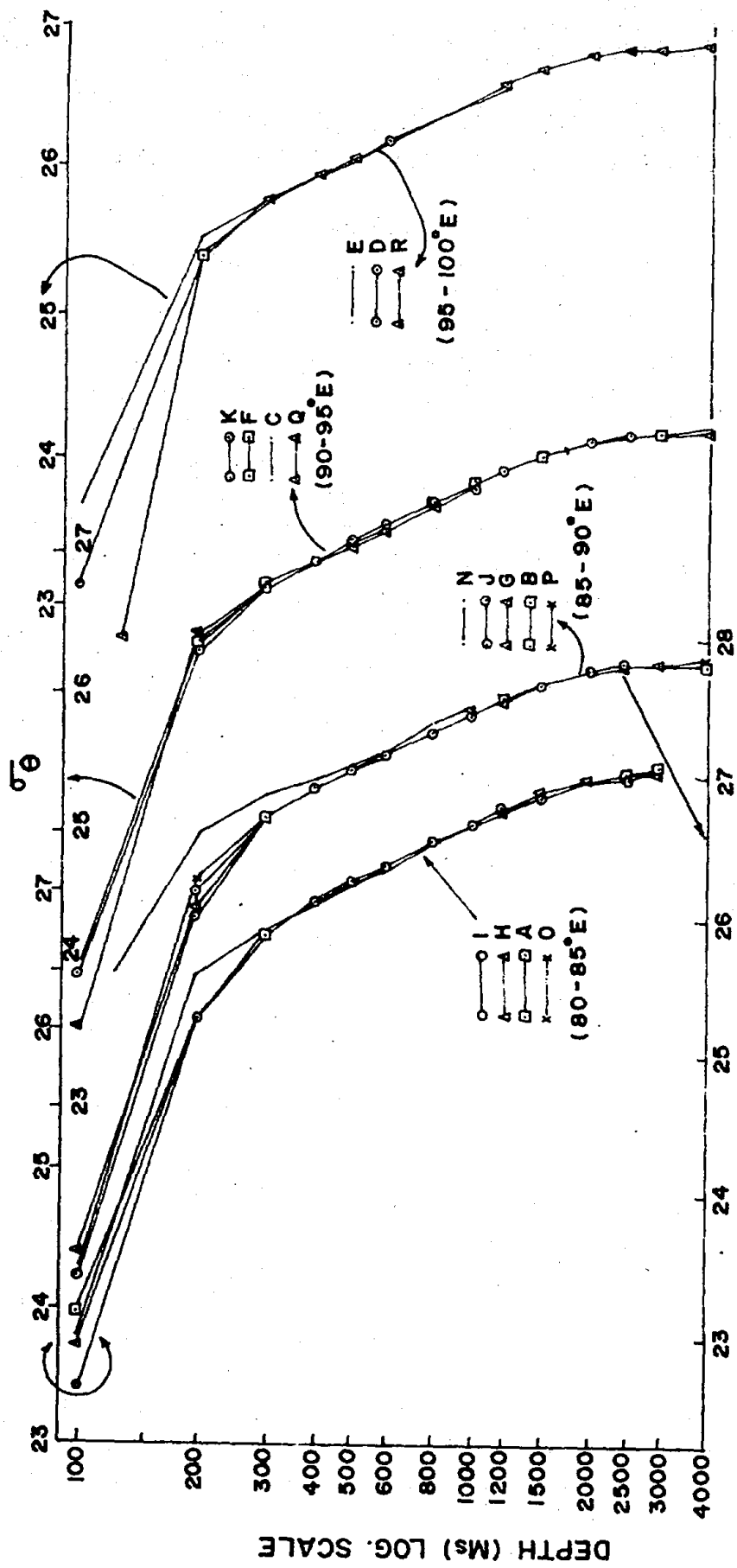


Fig. 1. Sigma - θ against log (depth) for various zones.

excluding the Andaman Sea, the upward velocities would decrease linearly upwards following the above relationship giving K_z values as; $K_{400} = 8 \text{ cm}^2/\text{sec}$, $K_{800} = 16 \text{ cm}^2/\text{sec}$ and $K_{1200} = 24 \text{ cm}^2/\text{sec}$. The corresponding upward velocities are; $W_{400} = 4.9 \times 10^{-5} \text{ cm}/\text{sec}$, $W_{800} = 9.8 \times 10^{-5} \text{ cm}/\text{sec}$ and $W_{1200} = 14.7 \times 10^{-5} \text{ cm}/\text{sec}$. Here, it is to be noted that Veronis (1969) got a value of $4.6 \times 10^{-5} \text{ cm}/\text{sec}$ as upward velocity at great depths (in the thermocline domain) from observed data using a seasonal thermocline model. His estimates for K_z varied between 0.15 and 2 cm^2/sec . This difference is perhaps explainable on the basis that the present estimates are from long term mean profiles, neglecting horizontal advection.

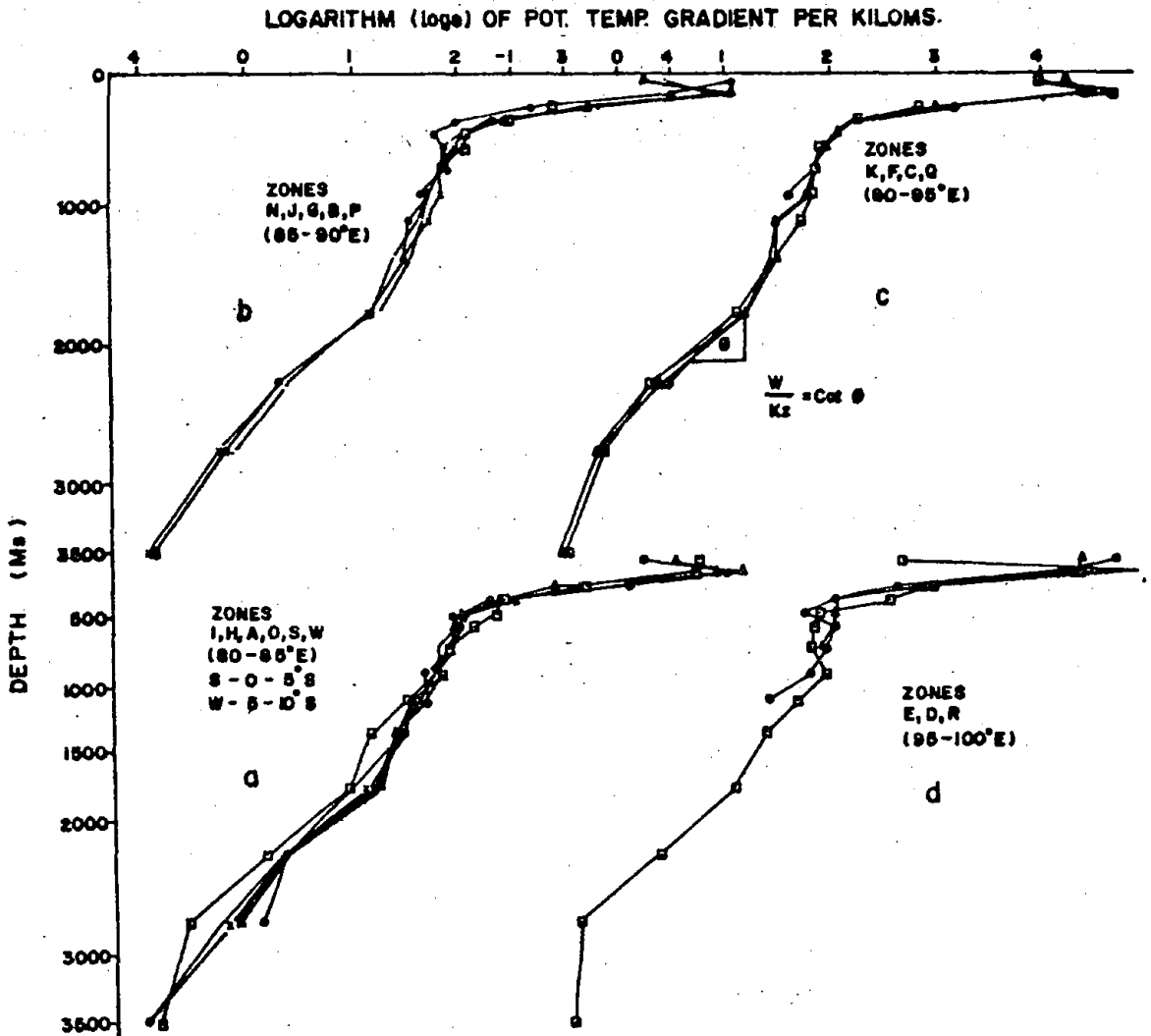


Fig. 2. Log $(d\theta/dz) \times 1000$ against depth for various zones.

In the Andaman Sea (Fig. 2d), the logarithmic zone is broken into two linear segments from 400 to 900 m and 900 to 1100 m with W/K_z values of 5.5×10^{-7} and $1.9 \times 10^{-6} \text{ cm}^{-1}$, respectively. This segmentation into two parts is thought to be due to enclosed nature of the Andaman Sea below 200 m. Using the value of $14.7 \times 10^{-5} \text{ cm}/\text{sec}$ of W for the western Bay, K_{1100} is found to be $78 \text{ cm}^2/\text{sec}$. This is

possible due to the enclosed nature of the sea and vertical mixing would be largely influenced by vertical advection, compared to the western Bay.

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