TRI-AXIAL ELECTRIC FIELD MEASUREMENTS FOR DETERMINING DEEP OCEAN WATER MOTIONS: TECHNIQUES AND A PRELIMINARY APPLICATION

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ABSTRACT

Deep ocean electric field measurements provide information on oceanic water motions and on the electrical conductivity structure of the earth's crust. The present work concentrates on the determination of oceanic tidal motions from tri-axial electric field data. The vertical component of the sea floor electric field allows an improvement over previous techniques for the separation of the oceanic and ionospheric parts of the horizontal field, and also permits a better determination of the horizontal water velocity vector from the horizontal electric field. Simple theoretical models of electric current circulation in long barotropic deep ocean waves lead to techniques for approximating the effects of electric current flow on the measured electric fields. Simultaneous sea floor magnetic field measurements provide additional information on the horizontal electric current flow.

Two techniques for making tri-axial deep sea floor electric field measurements have been developed. A tetrahedron system has not worked successfully yet, but holds promise for future measurements at frequencies higher than about 6 cpd. Each component of a new long-span deployment technique has worked at least once, but a simultaneous tri-axial measurement has not yet been achieved. A 40 day measurement of the east-west component of the sea floor electric field at 27°03'N, 149°45'W has demonstrated the feasibility of using surplus torpedo guidance wire for long-span horizontal measurements. Proposed improvements to the method will provide better determination of relative sea floor array positions for future experiments.

Analysis of the 40 day E-W component record demonstrates a method for separating the ionospheric- and oceanic-induced components of sea floor electric fields. Simultaneous short span electric field measurements at nearby stations provide a calibration for the orientation and spacing of the long-span measurement. A concurrent magnetic field record from the same site allows an estimate of the horizontal electric current flow to permit the determination of the North-South water velocity component.

Tidal current velocities estimated from cotidal charts by calculation of horizontal gradients of the complex sea surface elevation provide a criterion for choosing which of several proposed cotidal charts best fits the measured tidal currents. Wide disparity is found between the currents predicted from several published charts, and none agrees well with the measured tidal currents. The technique appears to hold promise for future verification of cotidal chart features by comparison with water velocity measurements.