Supplementary Materials for

Marine electrical imaging reveals novel freshwater transport mechanism in Hawai‘i

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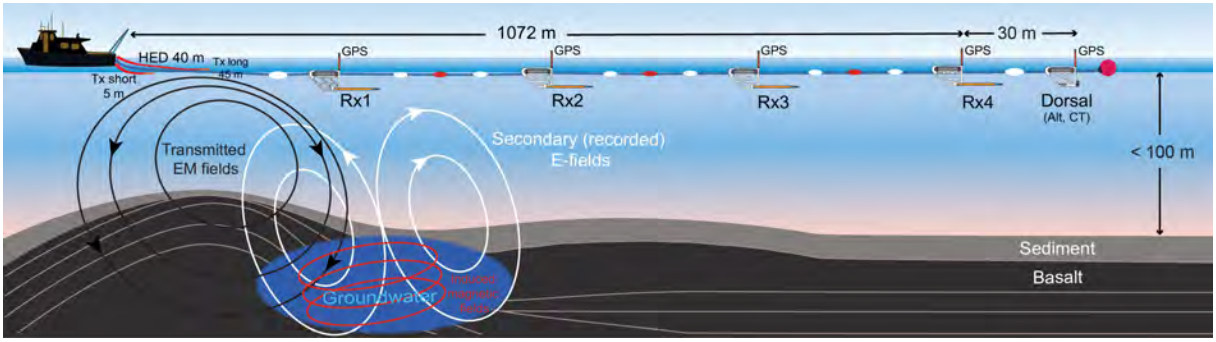
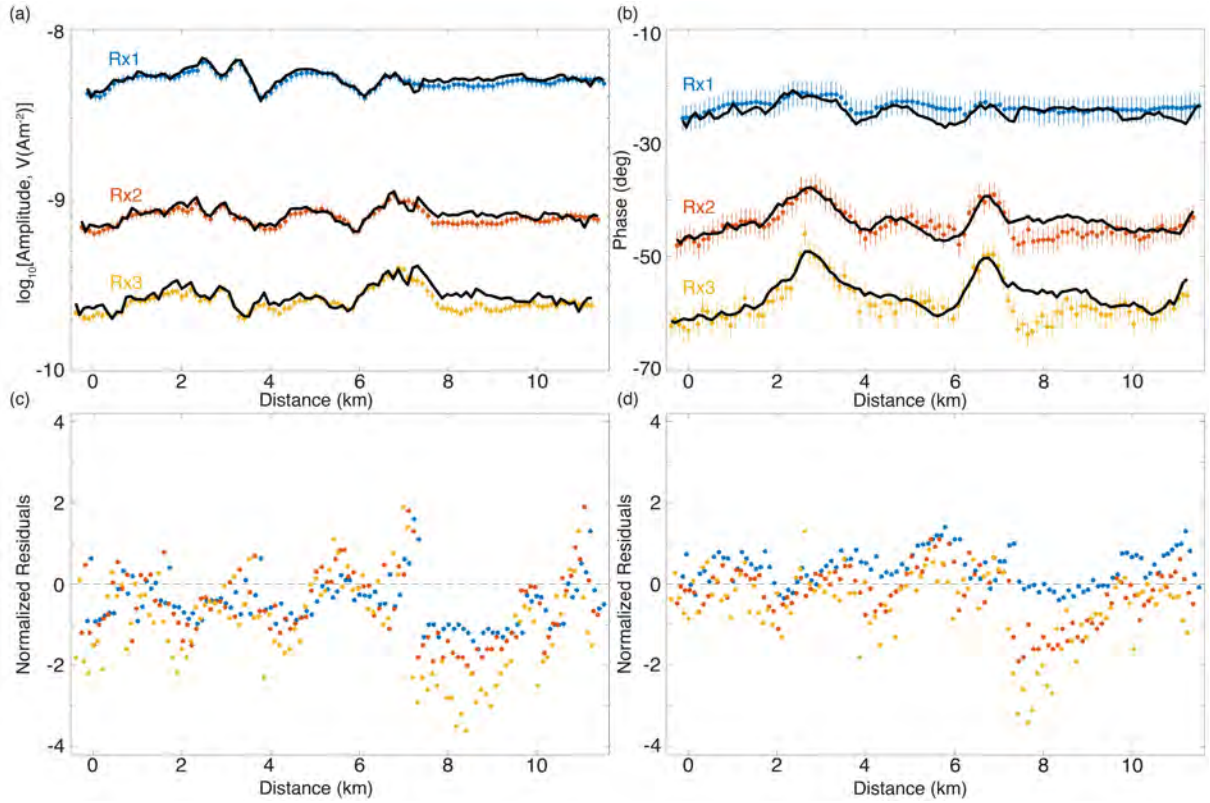
The PDF file includes:

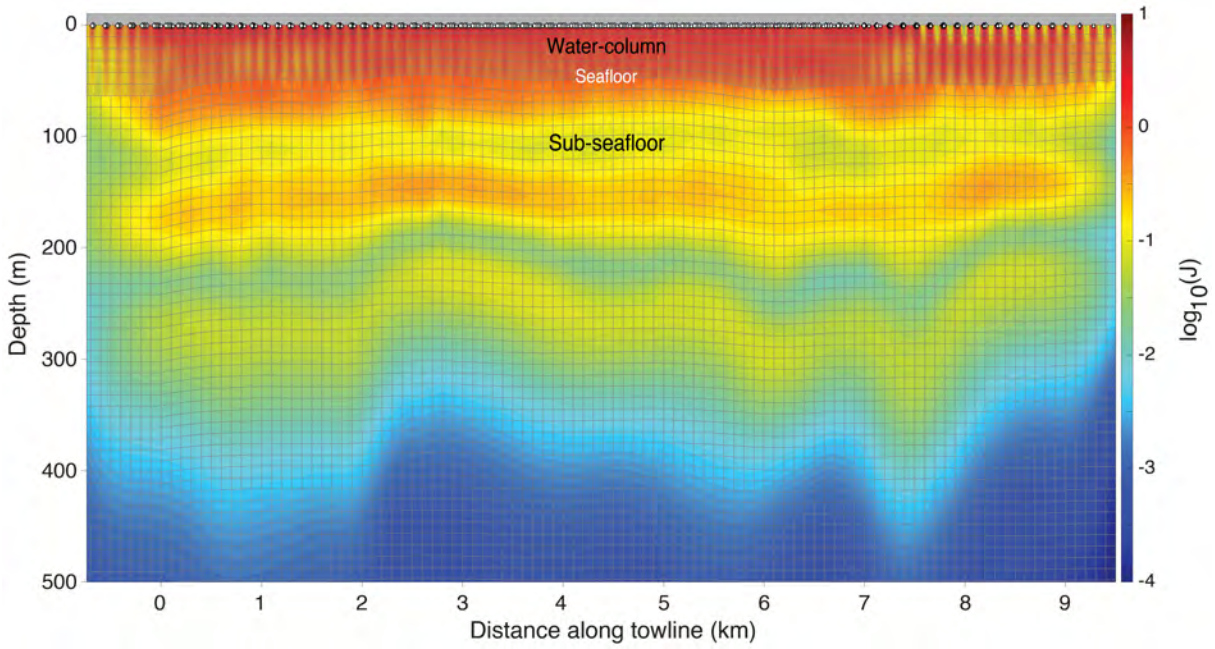
Figs. S1 to S5
Table S1



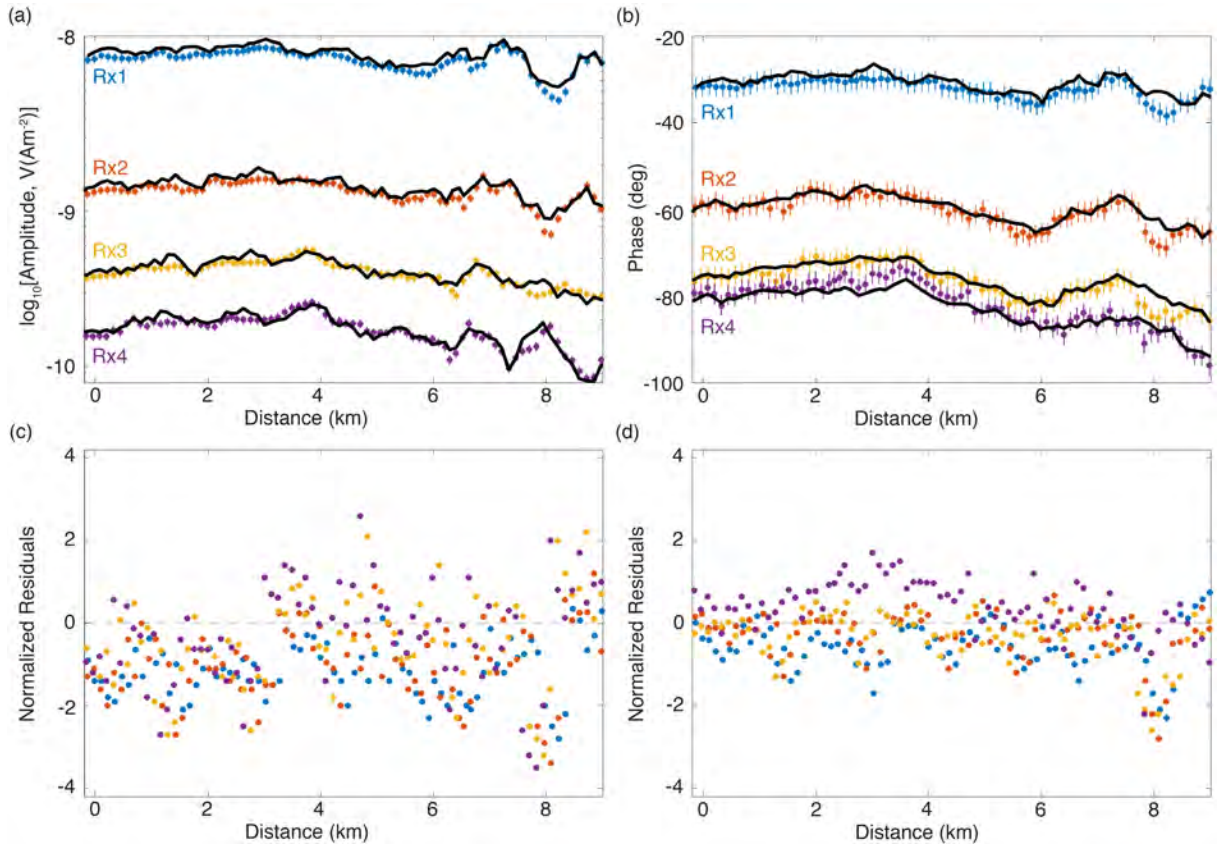
Supplementary Figure S1: Schematic illustration of the surface-towed CSEM system. The system includes a 40 m horizontal electric dipole (HED) source transmitter that emits a current of 100 A and four receivers (Rx) at increment distance of $\sim$250 m to form a $\sim$1 km array. Each receiver includes a 2 m inline electric dipole, a data logger, and a GPS unit above sea level. At the end of the array, another unit is located (Dorsal), which consists of an altimeter (Alt), conductivity/temperature (CT) measuring device, and a GPS unit above sea level. The specific system setup used here (fundamental frequency, emitted current, dipole length, and source-receiver offset) limited the data acquisition to water depths less than 100 m. This system was designed and built at the Scripps Institution of Oceanography EM laboratory.



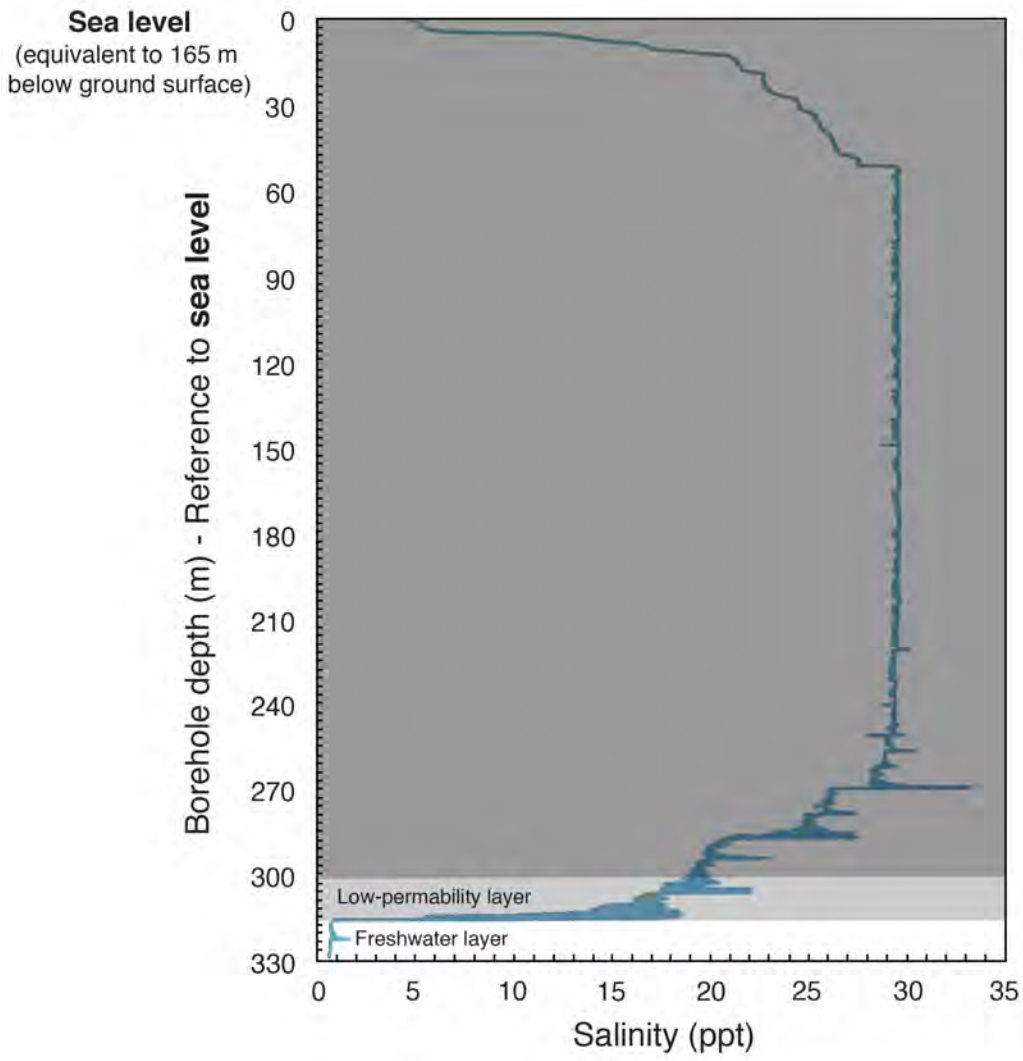
Supplementary Figure S2: line 3 North inversion model-to-data fits. The model-to-data fit and normalized residuals of the isotropic inversion applied to line 3 North data (Fig. 3, main article). The inversion includes data from three surface-towed receivers (Rx1, Rx2, Rx3) at frequencies 3 and 7 Hz, and fit the data to an RMS misfit of 1.0. (a) Amplitude model-to-data fit at 3 Hz, (b) Phase model-to-data fit at 3 Hz. The black lines denote the model responses, dots the CSEM data, and vertical lines the corresponding uncertainty bars. Panels (c) and (d) represent the amplitude and phase normalized residuals, respectively.



Supplementary Figure S3: Data sensitivities. Model showing the data sensitivities derived from the inversion model of line 3 North (Fig. 3, main article). The sensitivity matrix evaluates the data sensitivity to model parameters. The total sensitivities were computed as sums over all data points and normalized by data deviation and cell area. White squares and diamonds denote transmitter and receiver positions, respectively. Grey lines represent the quadrilateral mesh discretization applied to the seawater column and the sub-seafloor region of interest. Note the high-sensitivity to the multilayer formation shown in the main article Fig. 3.



Supplementary Figure S4: line 2 South inversion model-to-data fits. The model-to-data fit and normalized residuals of the isotropic inversion applied to line 2 South data (Fig. 4, main article). The inversion includes data from four surface-towed receivers (Rx1, Rx2, Rx3, Rx4) at frequencies 3 and 7 Hz, and fit the data to an RMS misfit of 0.99. (a) Amplitude model-to-data fit at 7 Hz, (b) Phase model-to-data fit at 7 Hz. The black lines denote the model responses, dots the CSEM data, and vertical lines the corresponding uncertainty bars. Panels (c) and (d) represent the amplitude and phase normalized residuals, respectively.



Supplementary Figure S5: Kamakana borehole salinity data. Salinity measurement obtained from the Kamakana borehole located onshore Hualalai west of Hawai‘i, approximately 3 km diagonally to survey line 2 south (Fig. 1). This borehole drilled from an elevation of 165 m amsl (height above mean sea level), encountered a thin basal freshwater aquifer at sea level that gradually transitioned to seawater salinity ($\sim$30 ppt). At a borehole depth of 300–315 m, a low-permeability layer is present (salinity of $\sim$15-20 ppt) and beneath it, a freshwater layer was detected (salinity $<$1 ppm). Note that the borehole data are projected to sea level. Borehole data: Courtesy of Tom Nance Water Resource Engineering and the University of Hawai‘i groundwater research program.

Supplementary Table S1: Inversion parameterization and properties. Details of the CSEM inversion models presented in the main article Fig. 2. MARE2DEM inversion code was used to invert the CSEM data in 2-D.

Inversion parameter	**Value range**
RMS misfit	0.98 – 1.0
Iterations	5 – 24
Amplitude error	4% – 10%
Phase error	2% – 8%
Normalized residuals	± 1 to ± 3
Signal-to-noise ratio	10 – 20
Spatial Horizontal/Vertical weight	3 – 12
Frequencies used in 10 inversion models	3, 7, 13 Hz
Frequencies used in 12 inversion models	3, 7 Hz
Free parameters	$\sim$10 k – 20 k