

MT3D Workshop, March 12–14, 2008

Effects of static shifts, surface topography, and sea water in 3D MT inversion results; practical aspects

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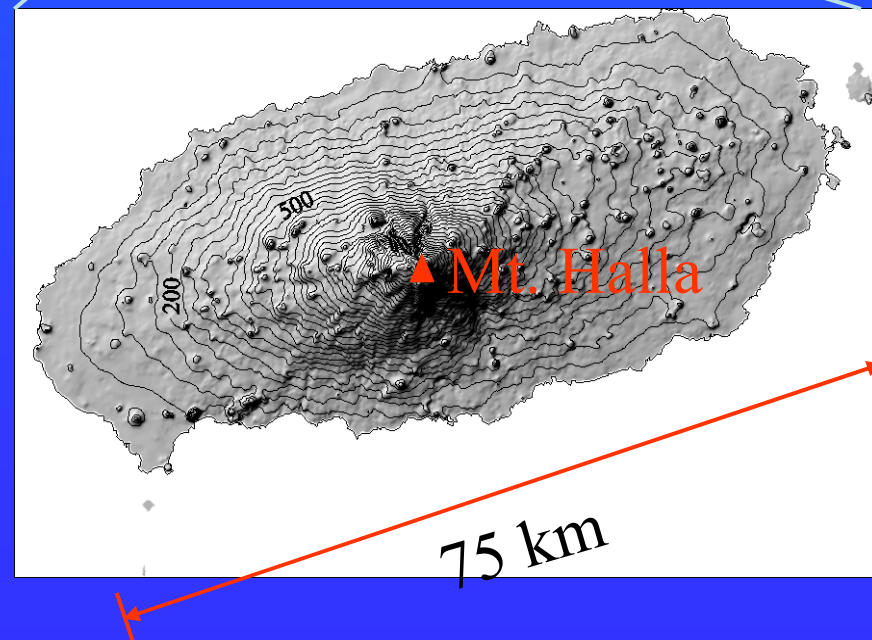
AIST



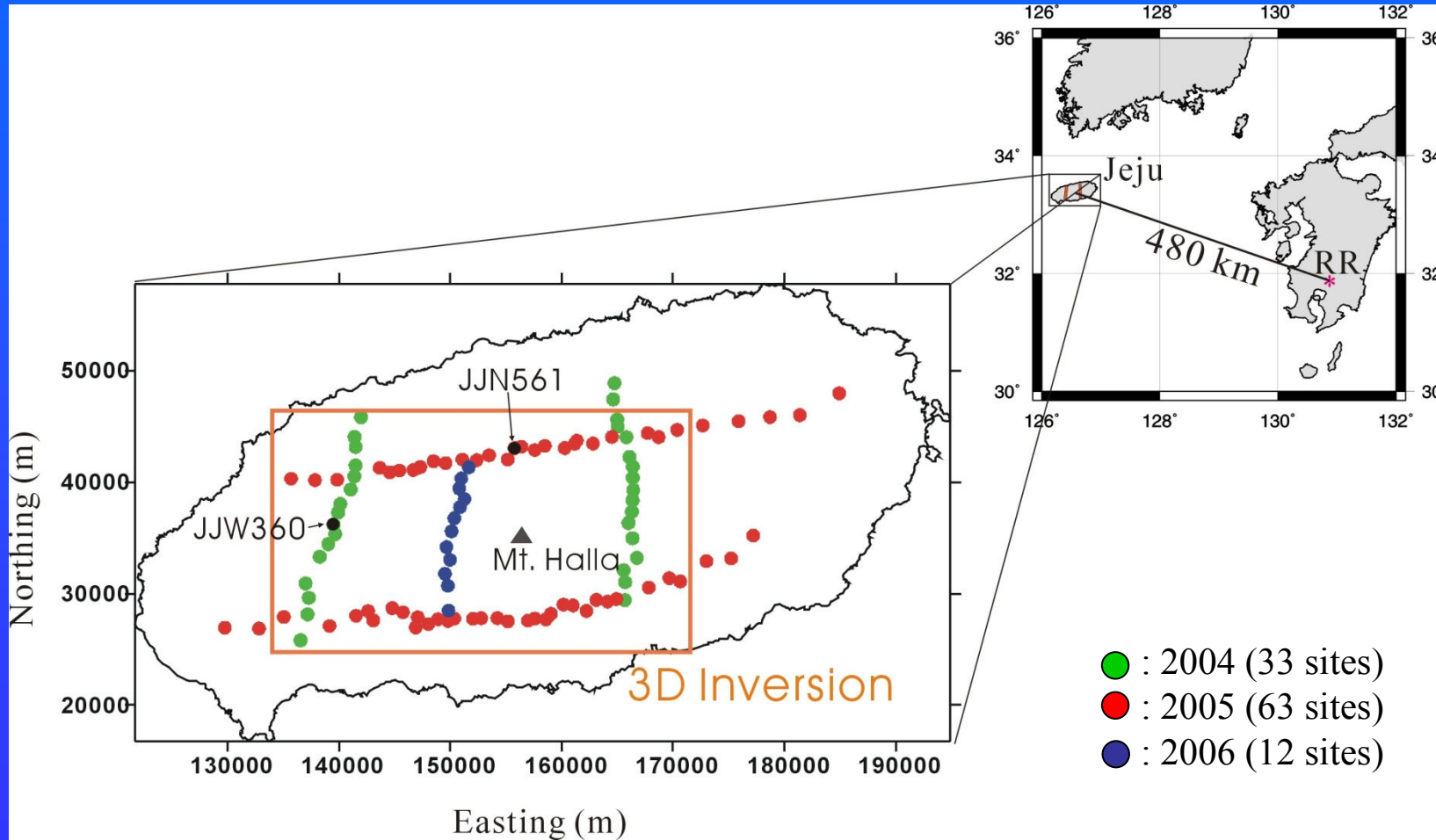
Background

MT surveys in Jeju volcanic Island, Korea

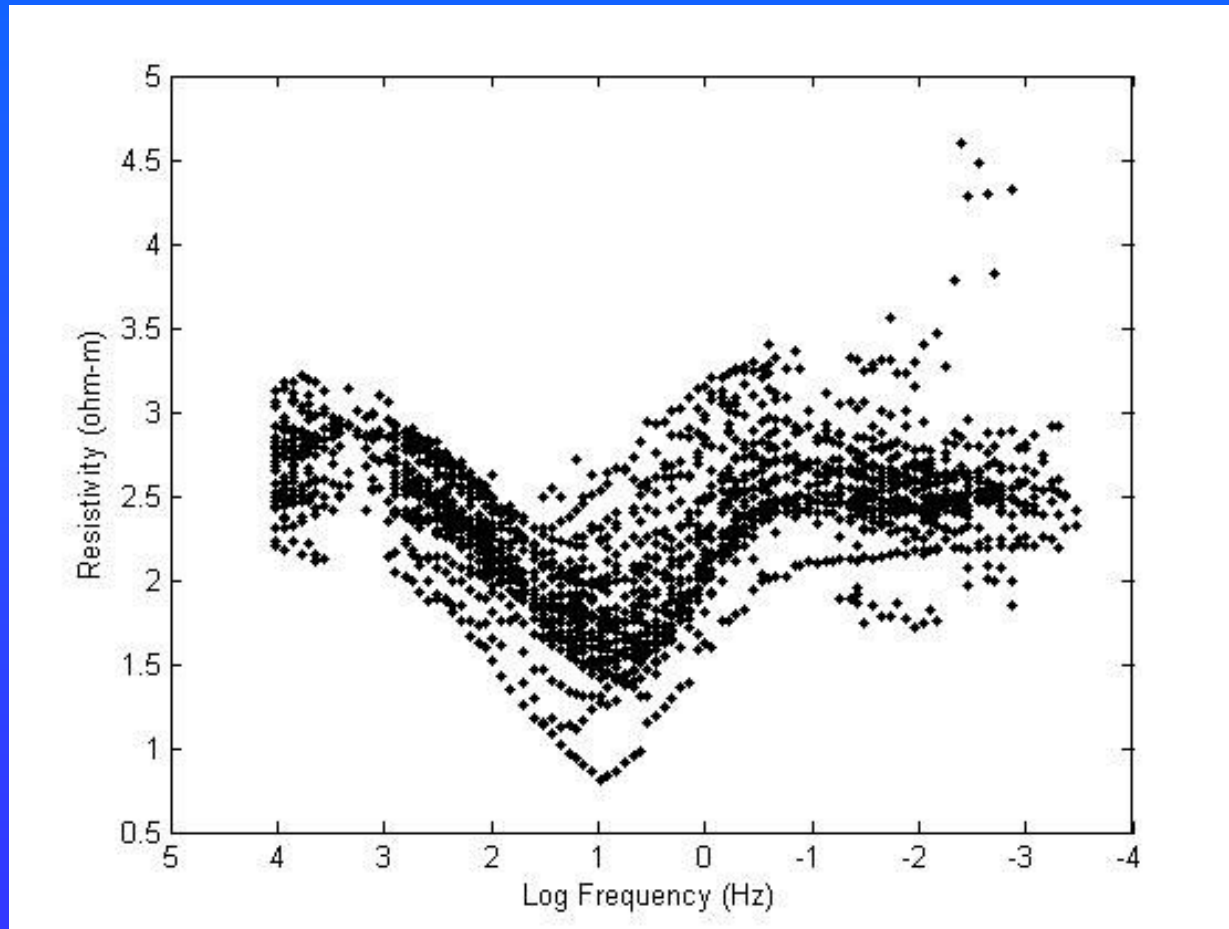
- **Purpose:** remnant geothermal regime?
 - Last eruption : YR 1007
- **Topography:**
 - very steep in S-N direction
 - Mt. Halla: 1,950m height.
- **Sea water:**
 - Surrounded by sea water
 - <100 m water depth
 - Overall flat sea bottom
 - Get deeper to the south



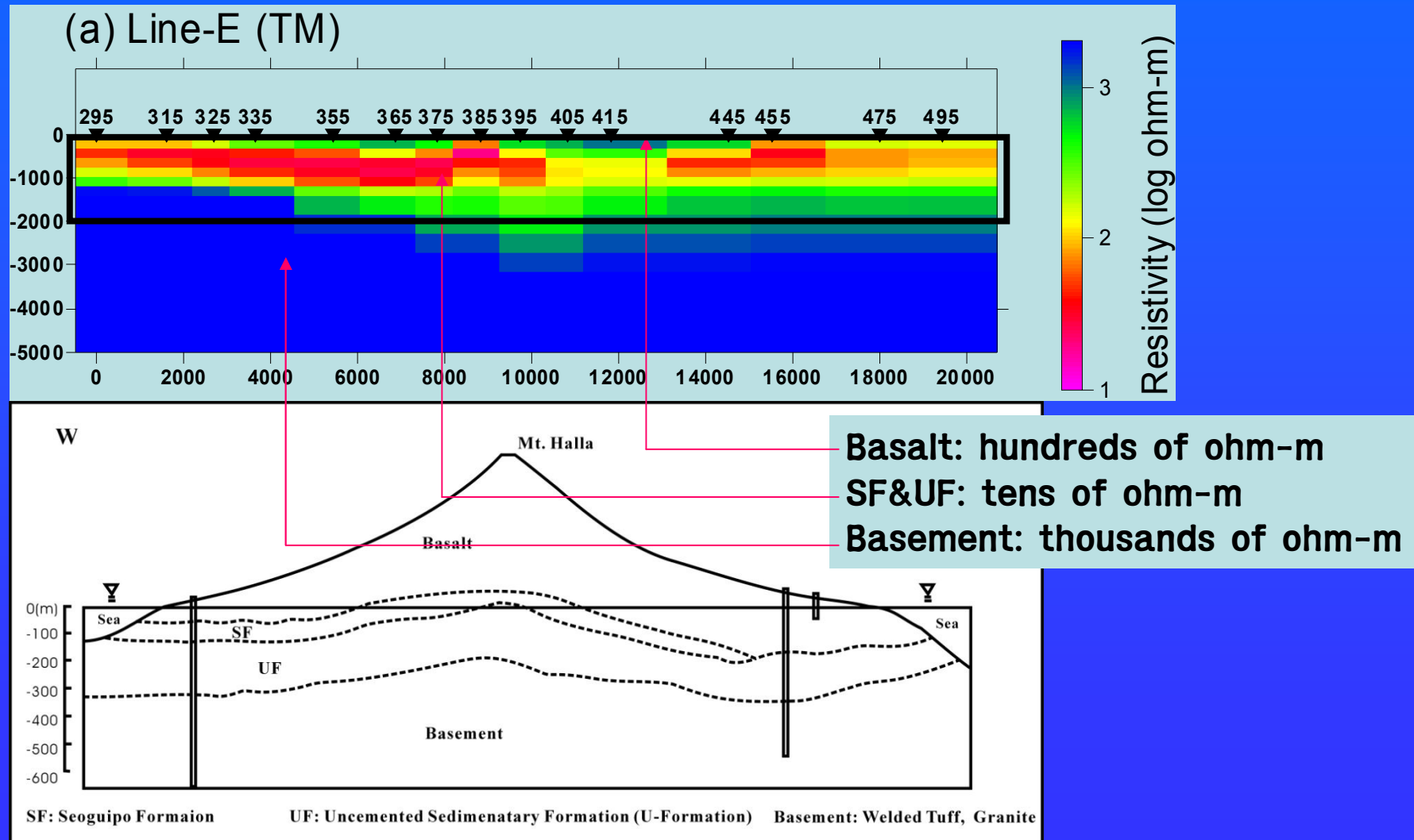
MT survey layout



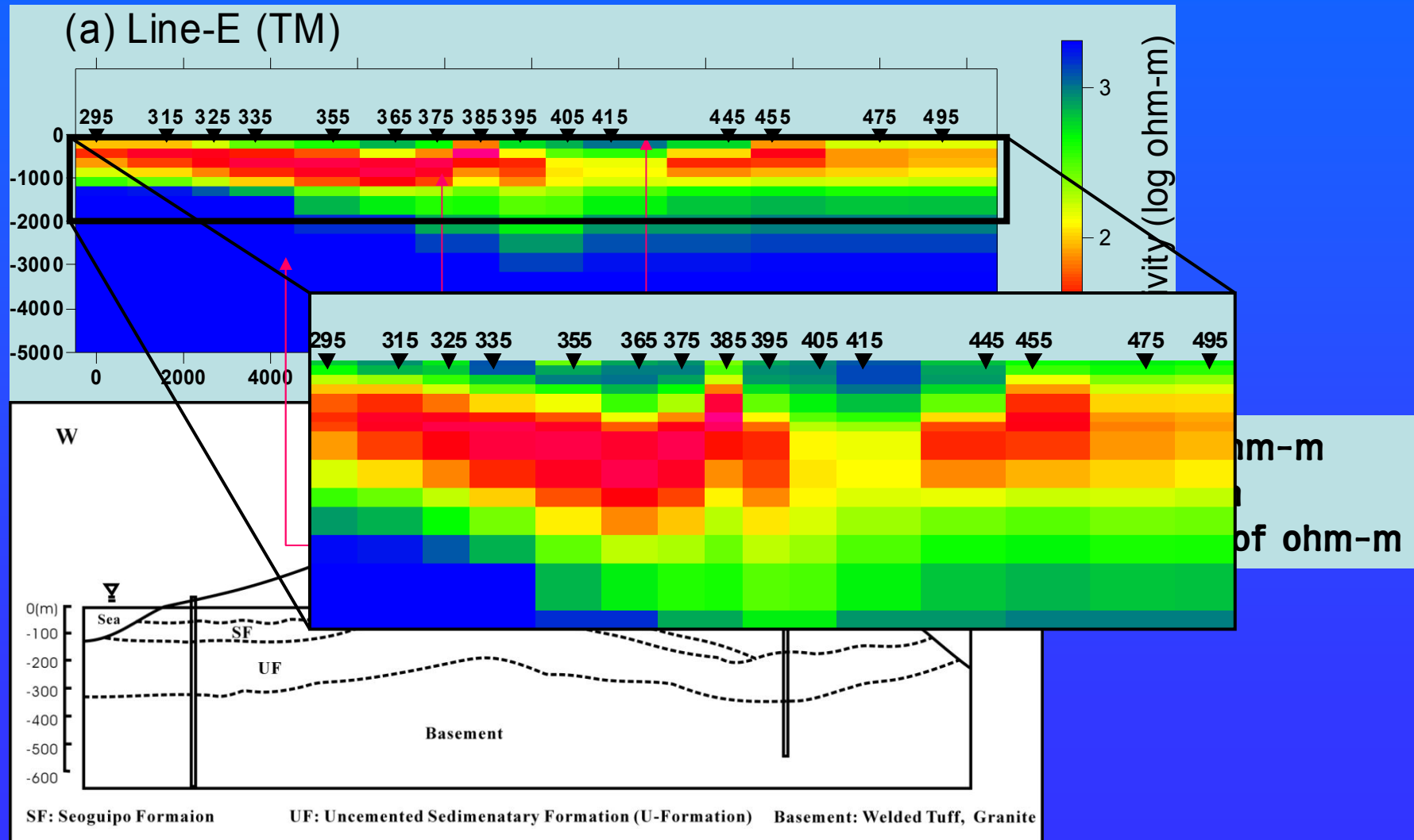
1. Static shifts in field data



2-D Inversion (TM mode)



2-D Inversion (TM mode)



Handling of the Static shifts

❑ **EMAP Spatial Filtering**

- Bostick, 1986 ; Torres Verdin (1985)

❑ **Modeling or use of auxiliary data**

- Wanamaker et al. (1984) ; Jones (1988)
- Sternberg et al. (1988); Pellerin and Hohmann (1990)
 - coincident TEM sounding data

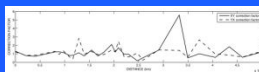
❑ **Parameterization in Inversion**

- deGroot-Hedlin (1991) – 2D MT inversion (sum zero assumption)
- Ogawa & Uchida (1996) – 2D MT inversion (ABIC, Gaussian static)
- Sasaki (2001) – 3D MT inversion

Static shift correction

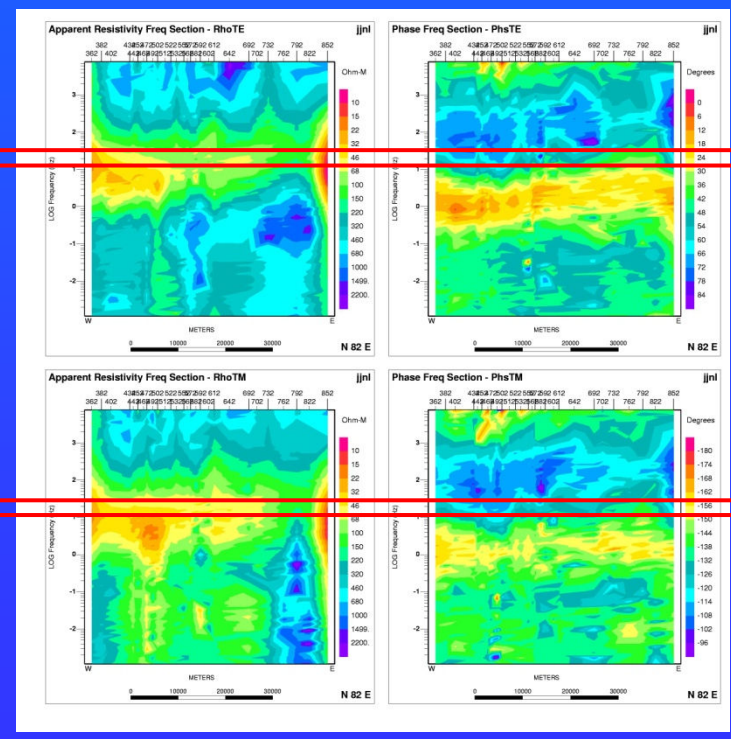
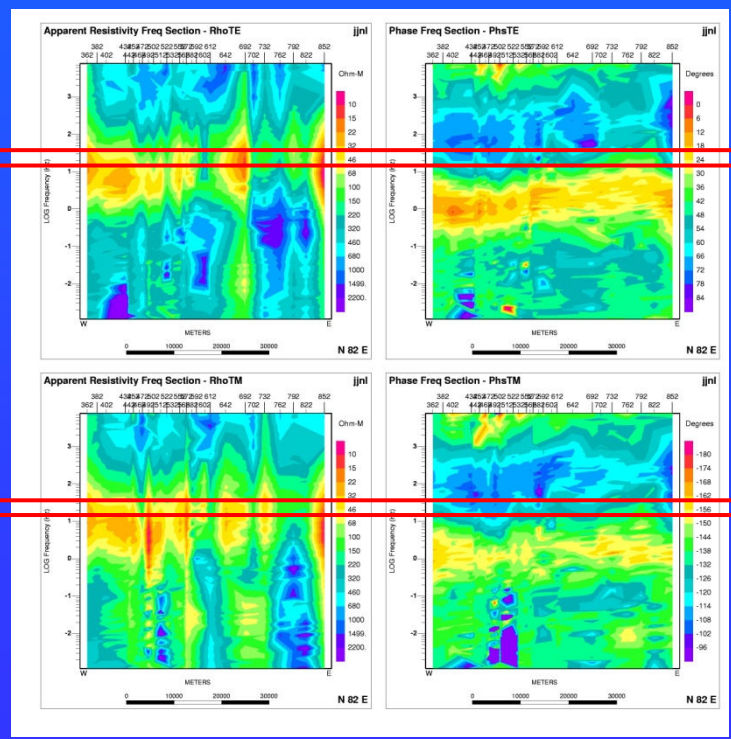
Field Data

Correction



TE

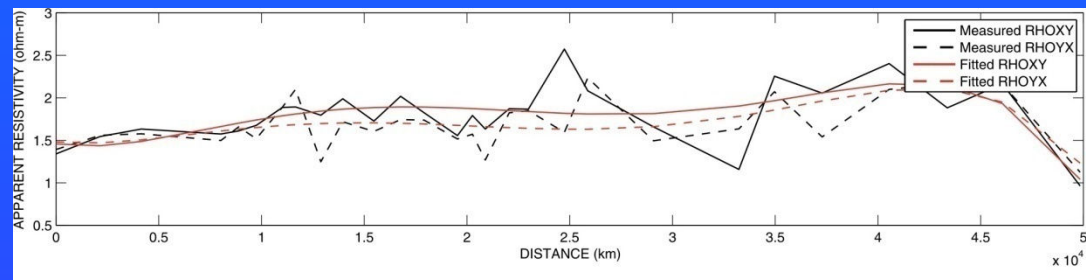
TM



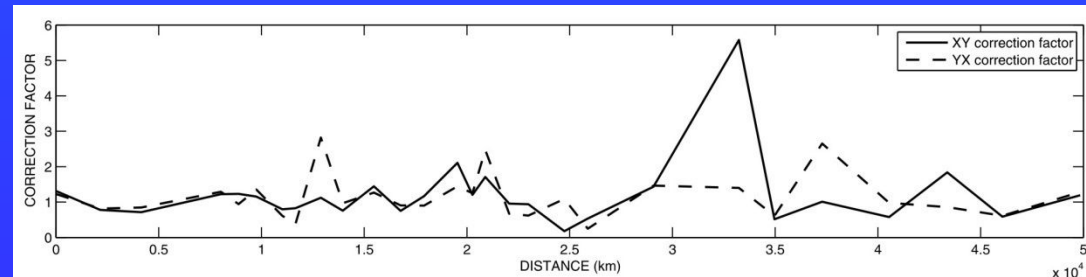
Smooth shallow subsurface

Average & Fitting

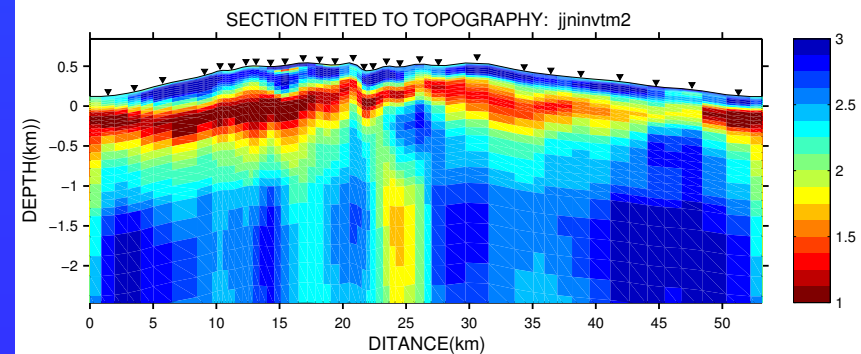
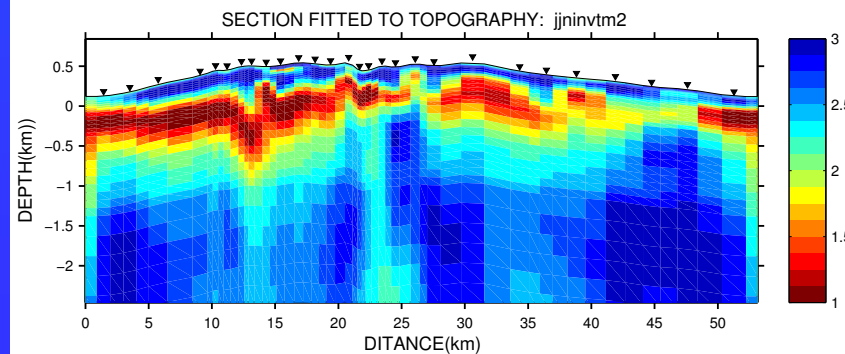
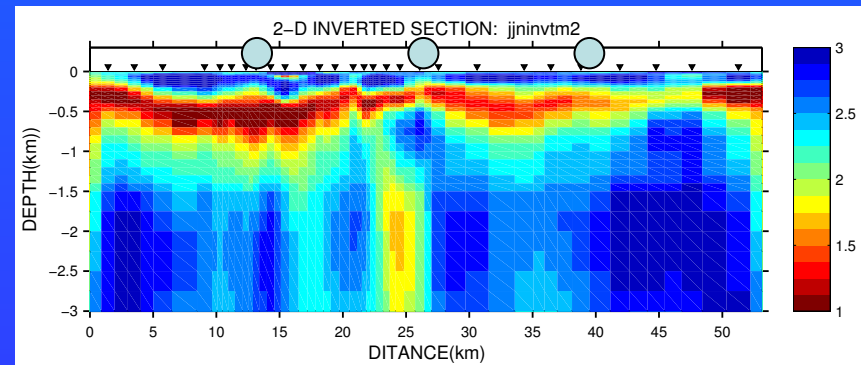
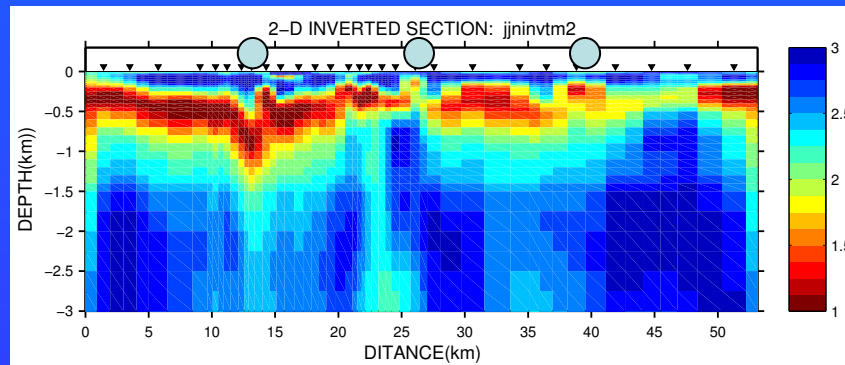
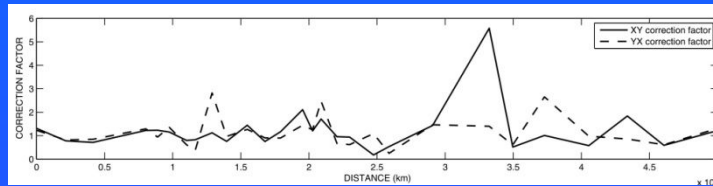
Frequency = 10-30 Hz



Correction Factor

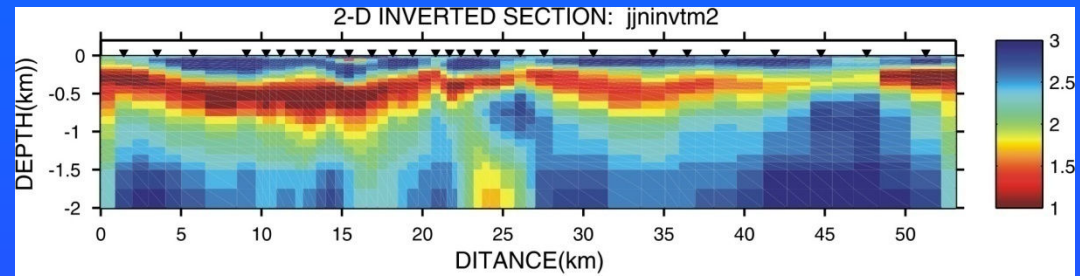


2-D Inversion (TM mode)

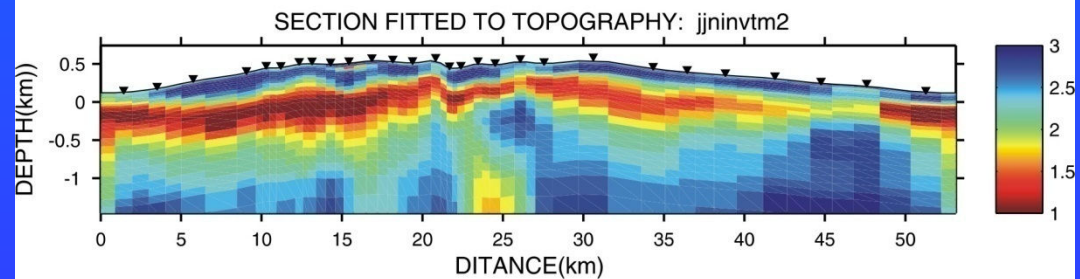


Estimation of depth to the U-layer

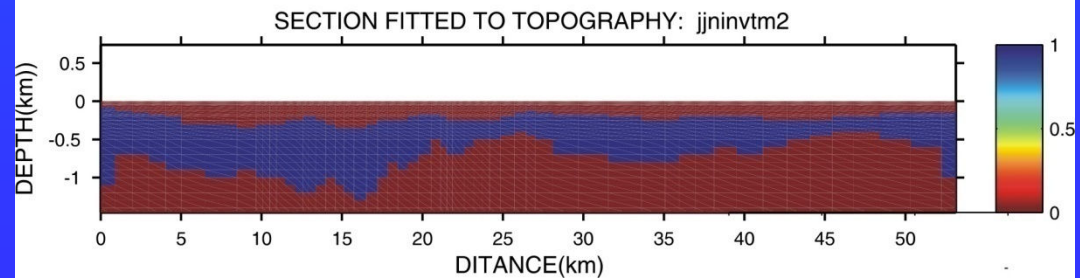
Inversion



Shift to Elevation

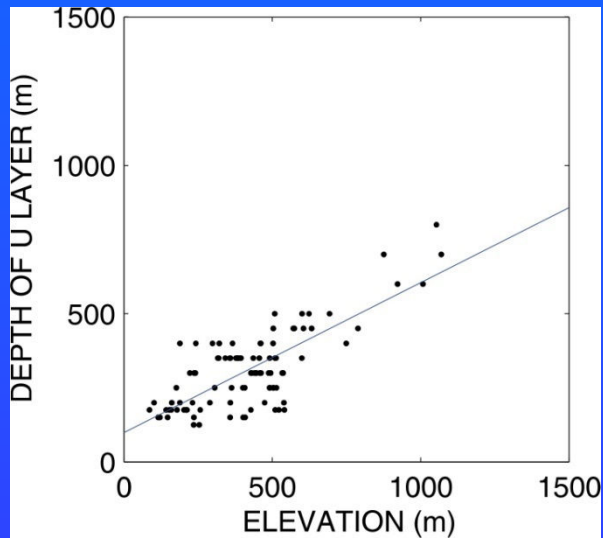


**100 ohm-m
contour**



Interpolation & Extrapolation

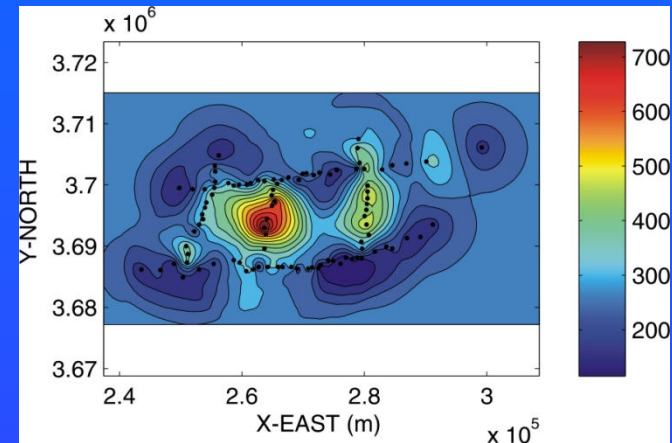
U layer depth vs. Elevation



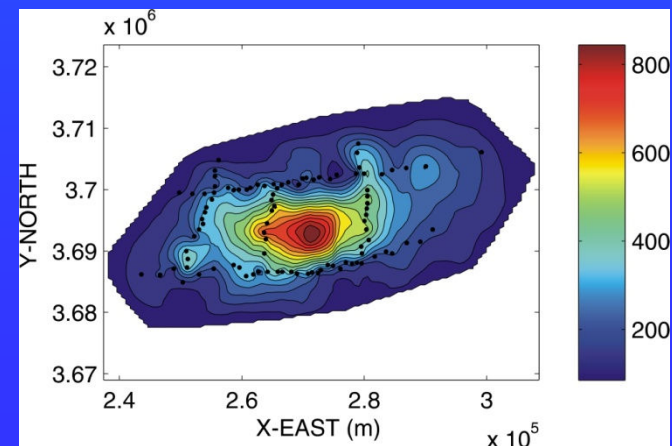
$$Z^*_{SK}(u) - m = \sum_{\alpha=1}^{n(u)} \lambda_{\alpha}^{SK}(u) [Z(u_{\alpha}) - m]$$

$$Z^*_{SKlm}(u) - m^*_{SK}(u) = \sum_{\alpha=1}^{n(u)} \lambda_{\alpha}^{SK}(u) [Z(u_{\alpha}) - m^*_{SK}(u_{\alpha})]$$

Ordinary Kriging

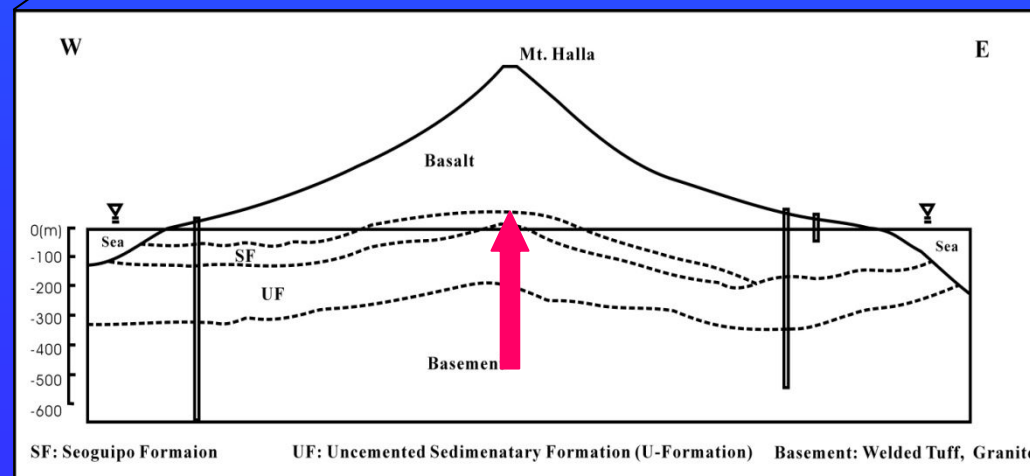
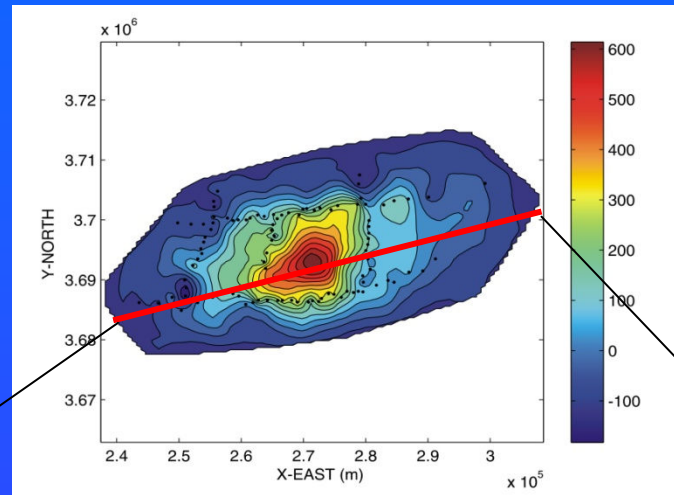


Simple Kriging with local means

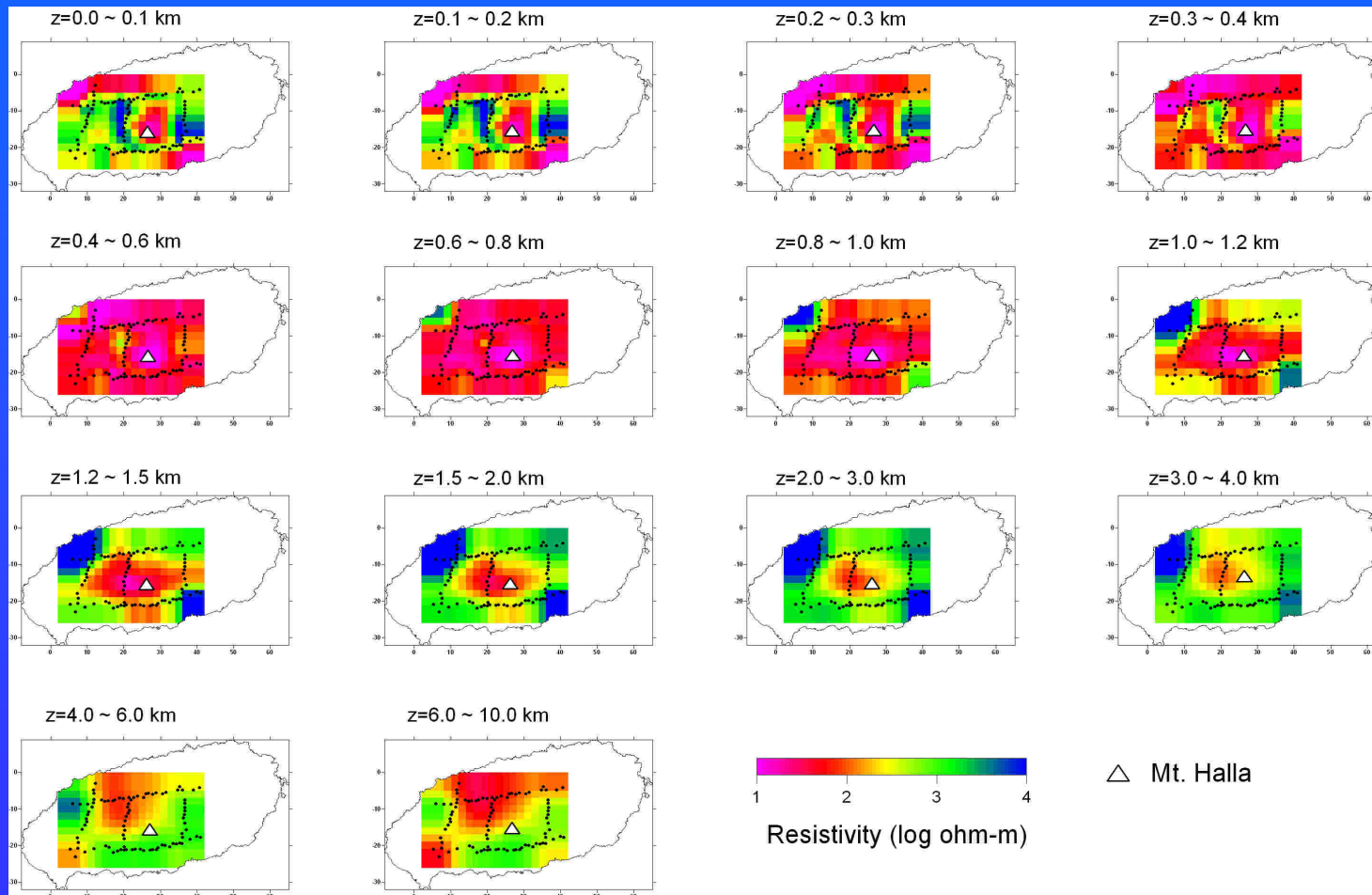


Comparison to General Geology

Elevation of top
of U-Layer

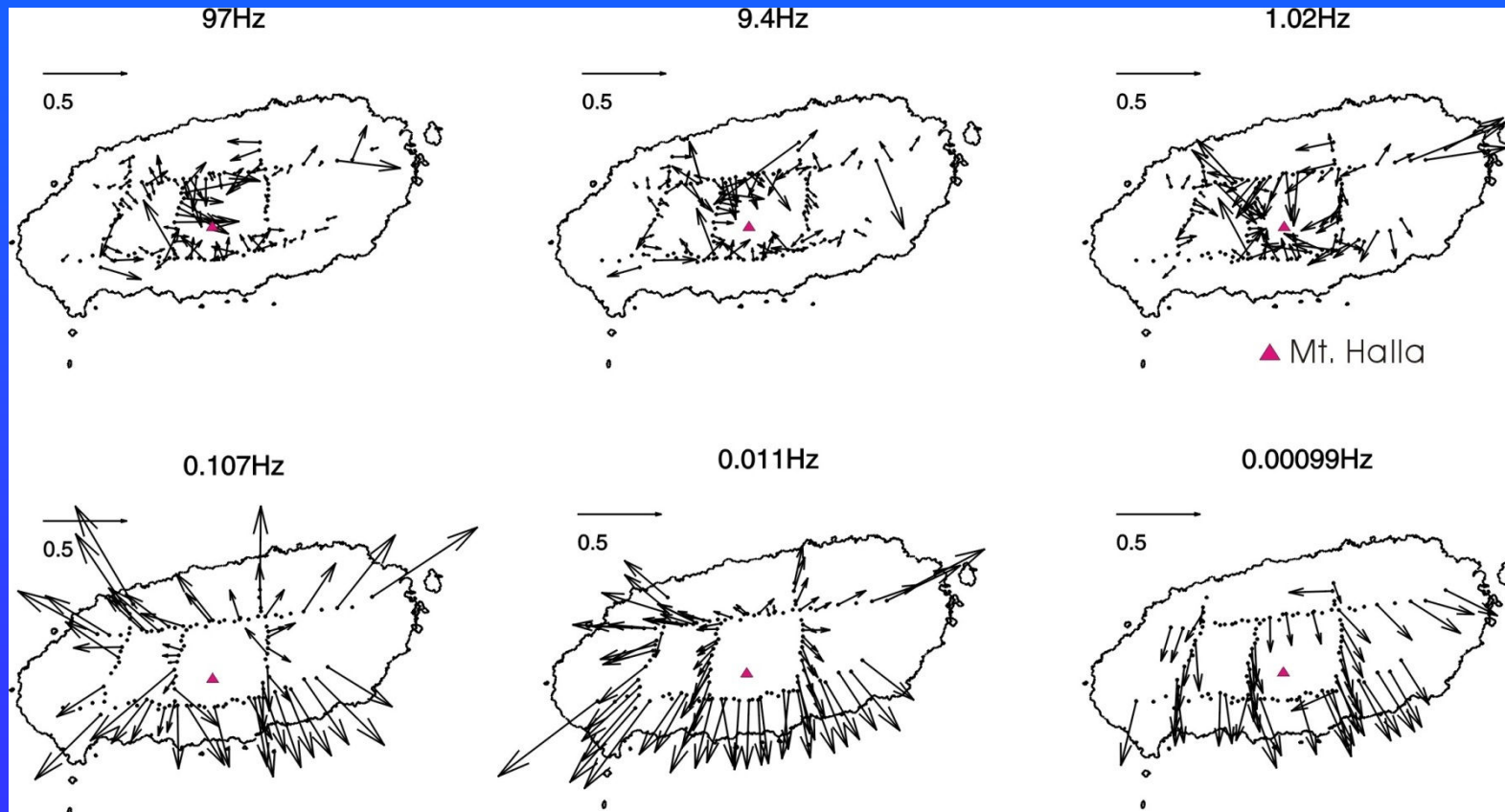


3-D inversion with Static shift estimation



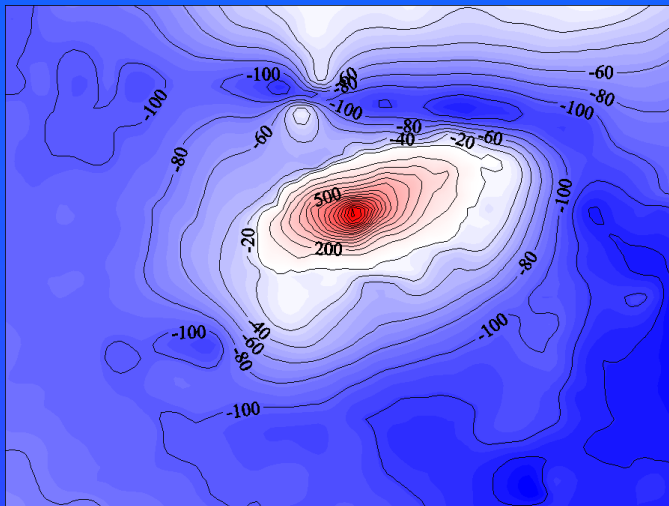
2. The Sea & Topography Effect

Induction vectors – field data

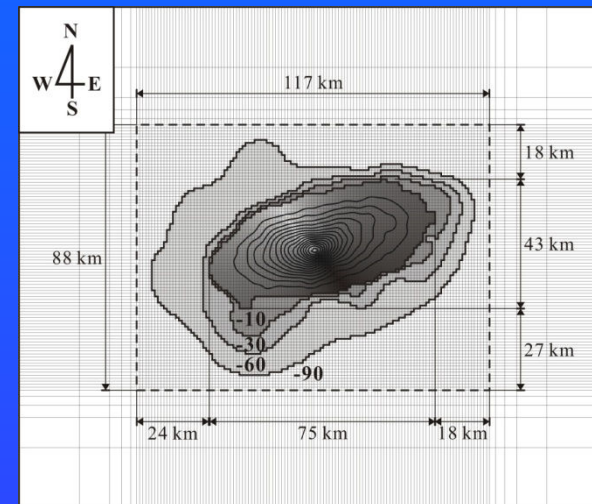


3-D Modeling including the sea and topo.

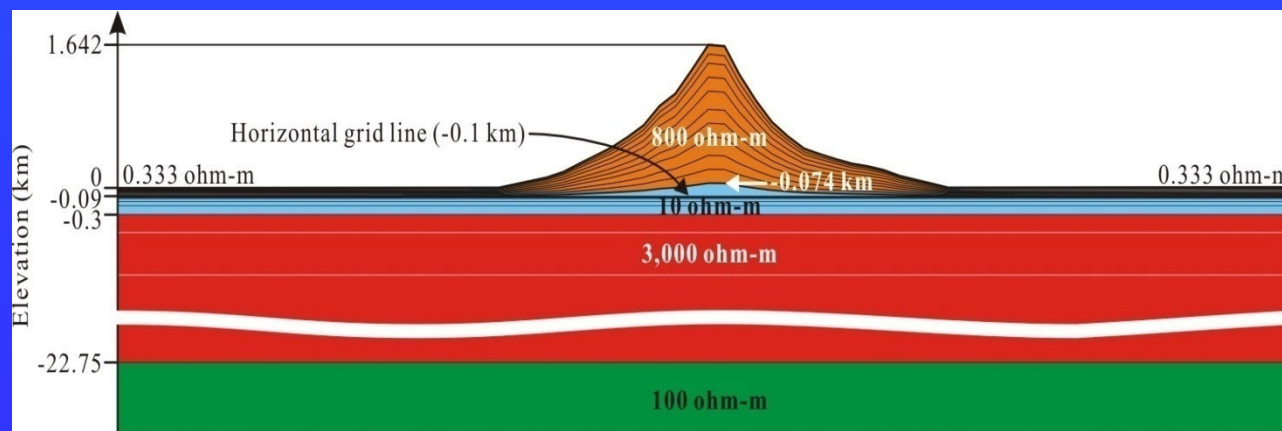
Topography & bathymetry



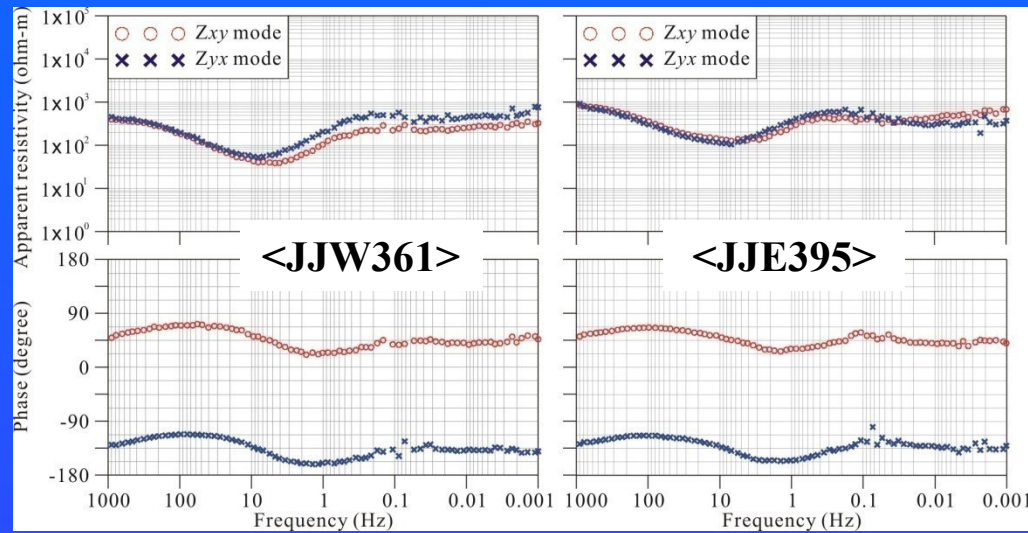
The 3D model (plan view)



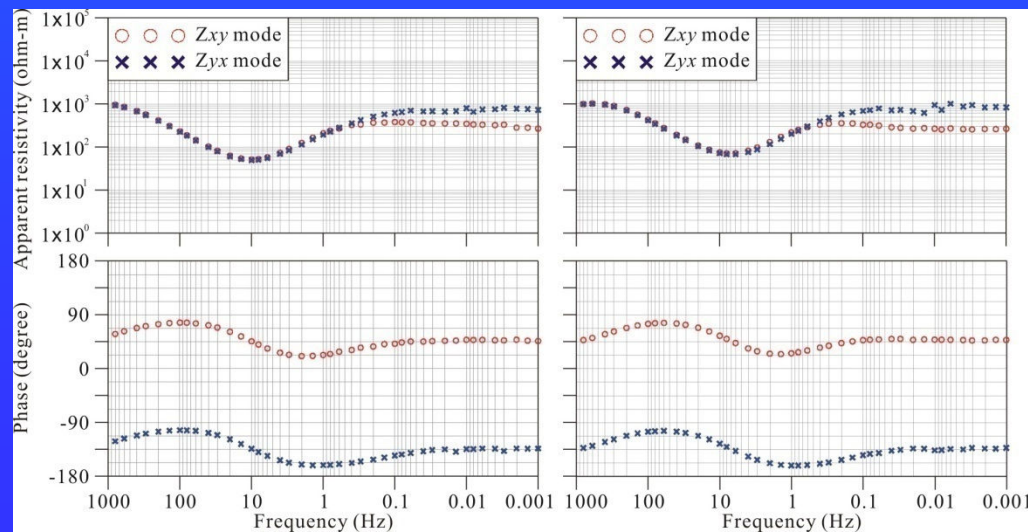
Layering



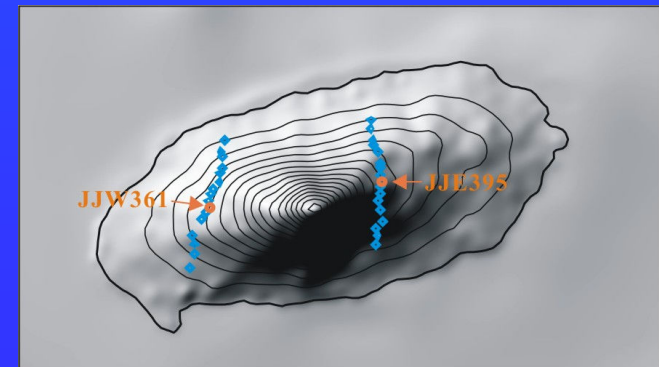
3-D Modeling including the sea and topo.



Measured data

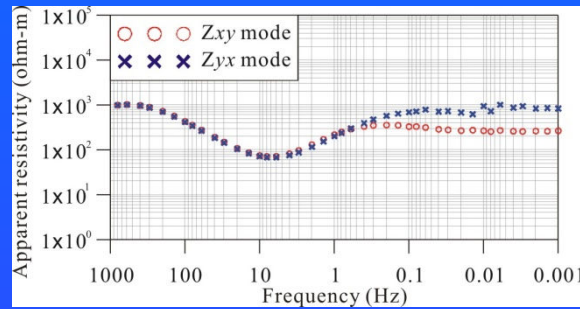


3D Modeling

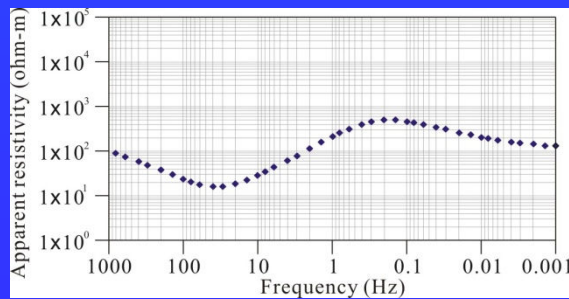
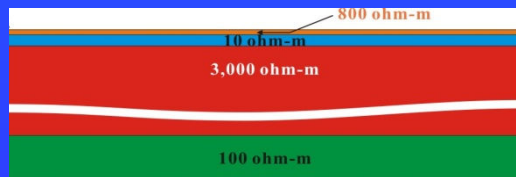


Effect of the sea and topography

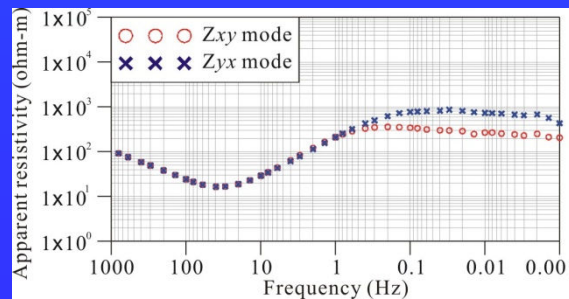
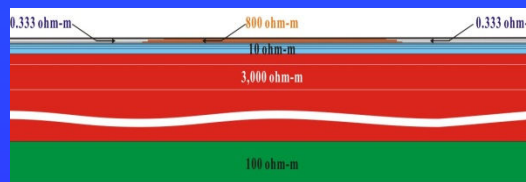
Everything - JJE395



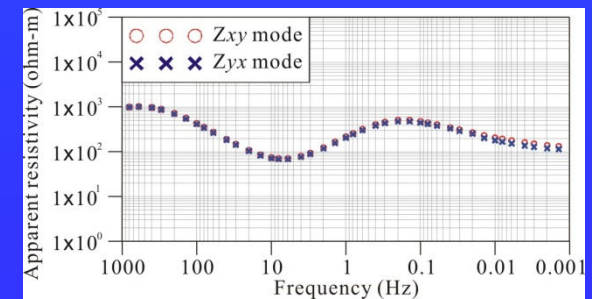
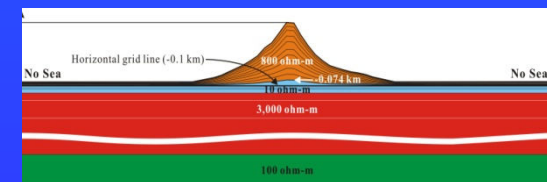
Nothing - 1D



The Sea only



Topography only

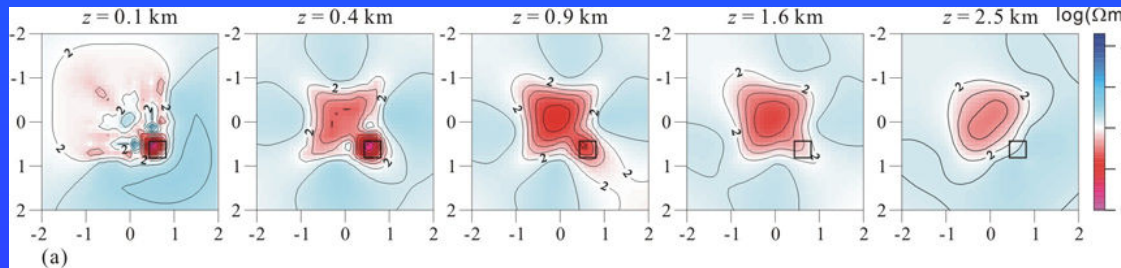


Impedance correction of topo. effect

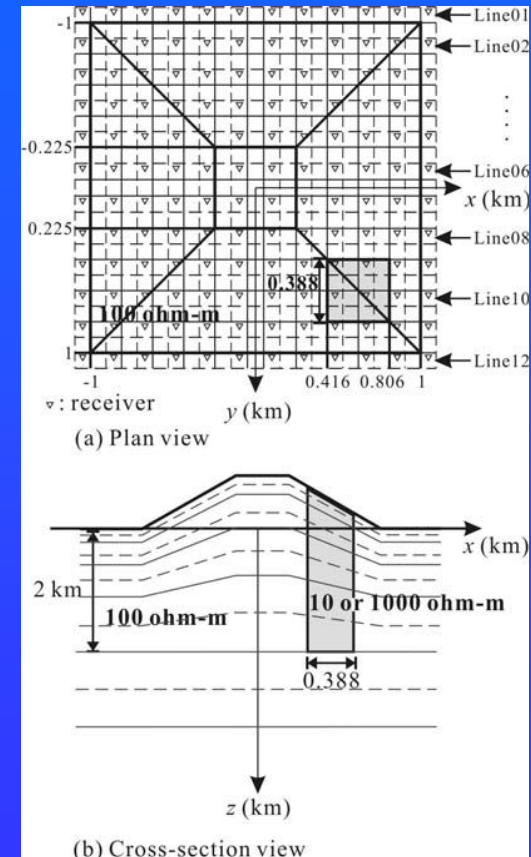
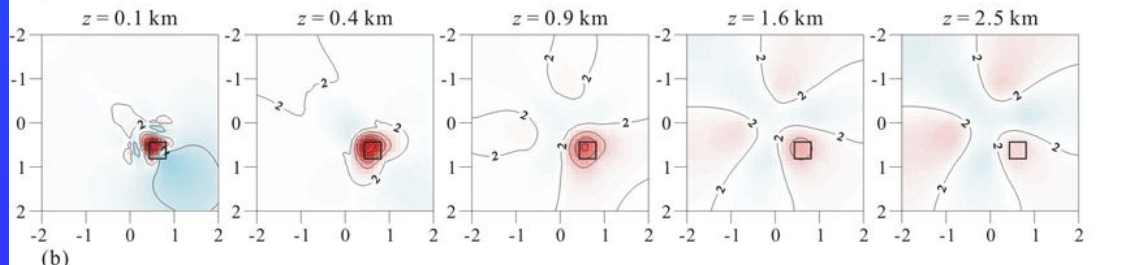
$$\mathbf{Z}^D = \mathbf{D}^Z \cdot \mathbf{Z}^U$$

$$\mathbf{Z}^t = \mathbf{D}^Z \cdot \mathbf{Z}^h$$

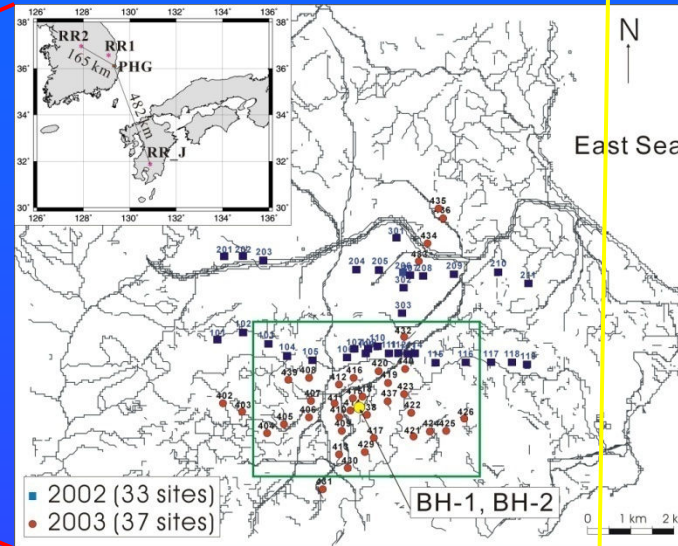
\mathbf{Z}^D



\mathbf{Z}^U

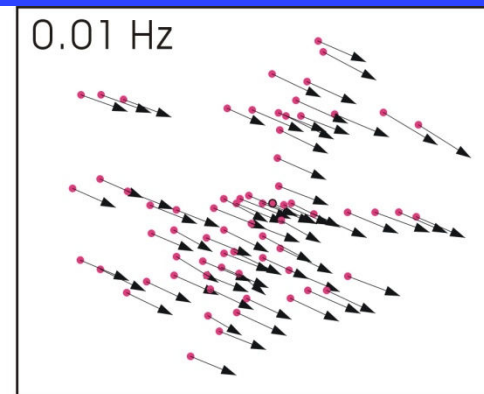
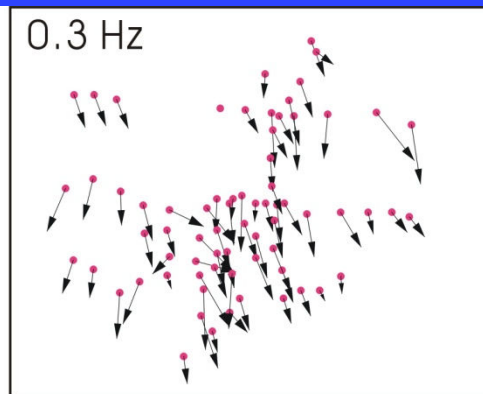
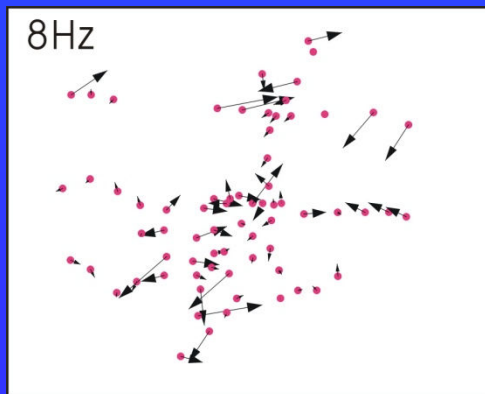


3D Inversion including the sea floor (Pohang)

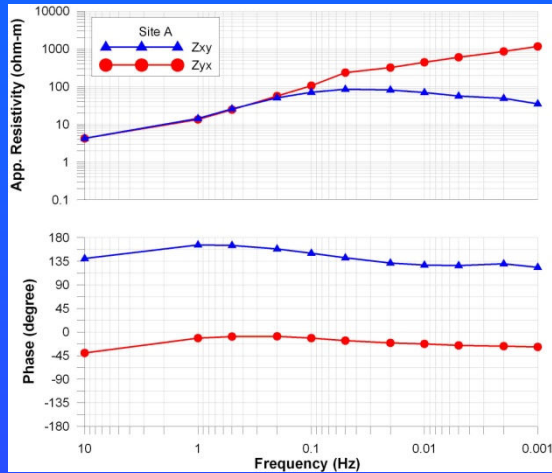


Induction vectors

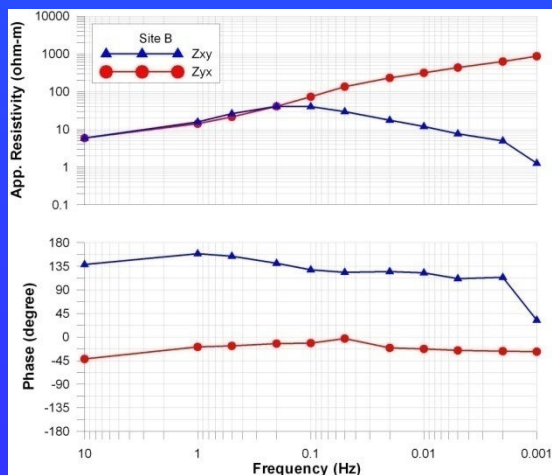
Simplified coast line



3D Modeling including the sea

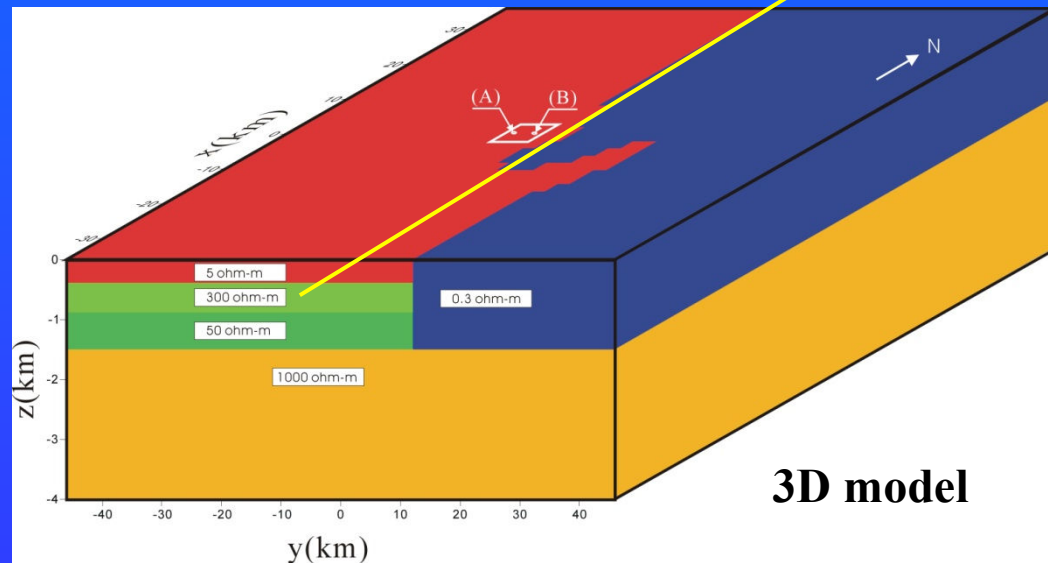


Site A



Site B

Simplified coast line



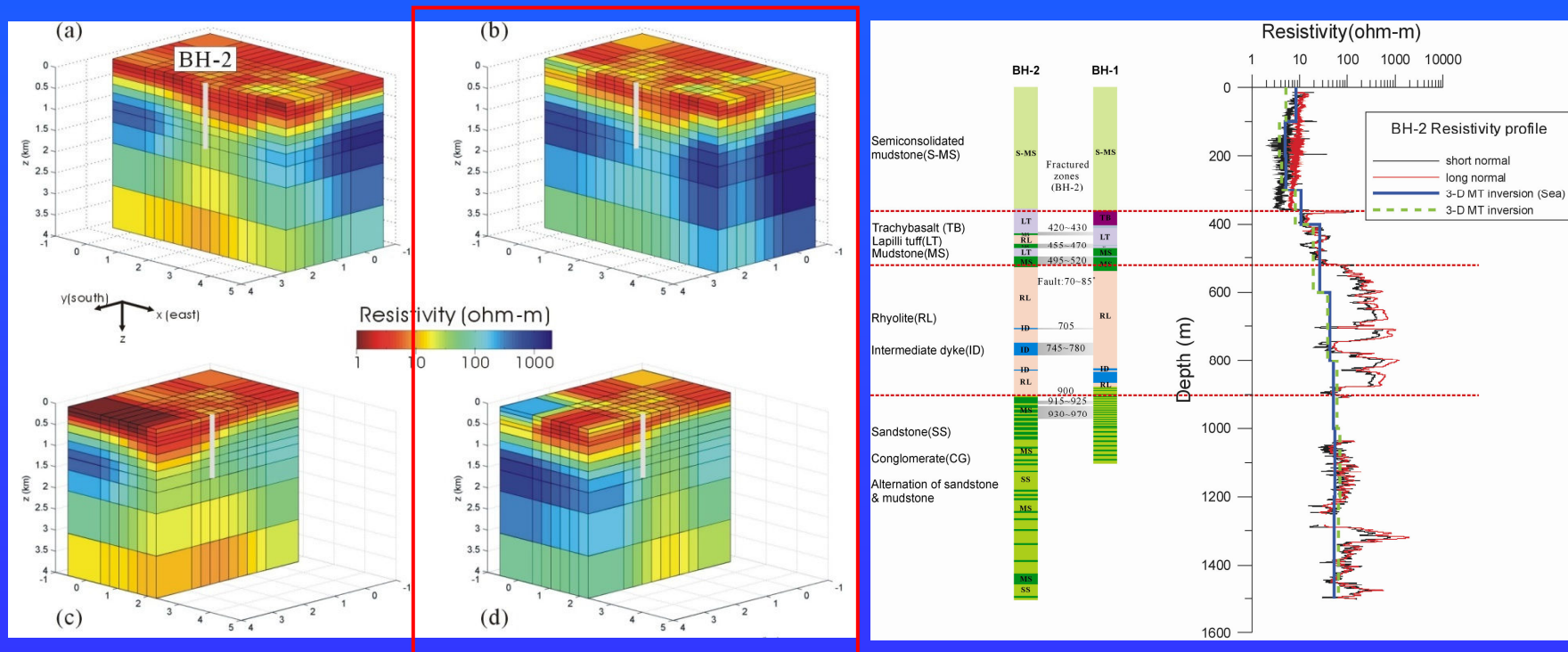
3D model

The sea affects the MT data below 1 Hz

(Lee et al., 2007)

3D Inversion including the sea

3D Inversion (Lee et al., 2007)



Including the sea

2. The Sea & Topography Effect

□ Impedance Correction

- Nam et al. (2007) –presented by Nuree Han (this workshop)
- Topography Correction using the code
- Feasibility study for correction method of the sea effect

□ 3D Inversion including topography

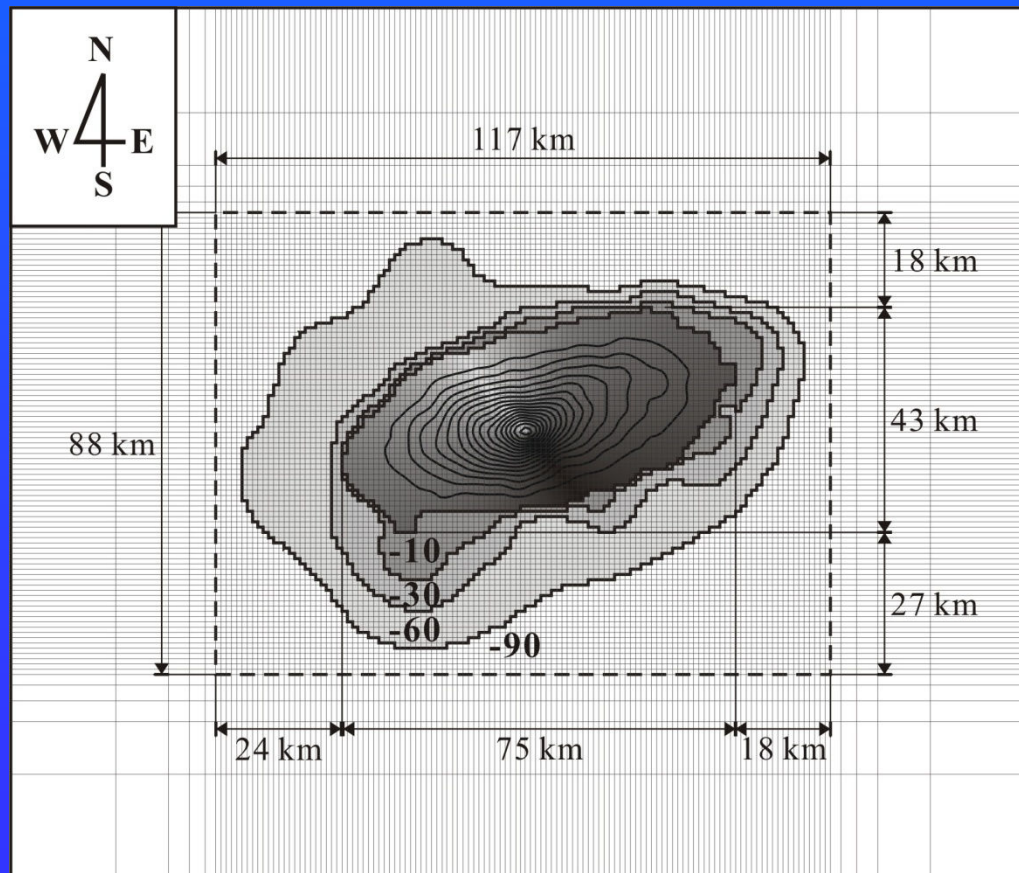
- is under developing (KIGAM & SNU)

□ 3D Inversion including sea floor topography

- Simplification of the coast line
- The boundary condition

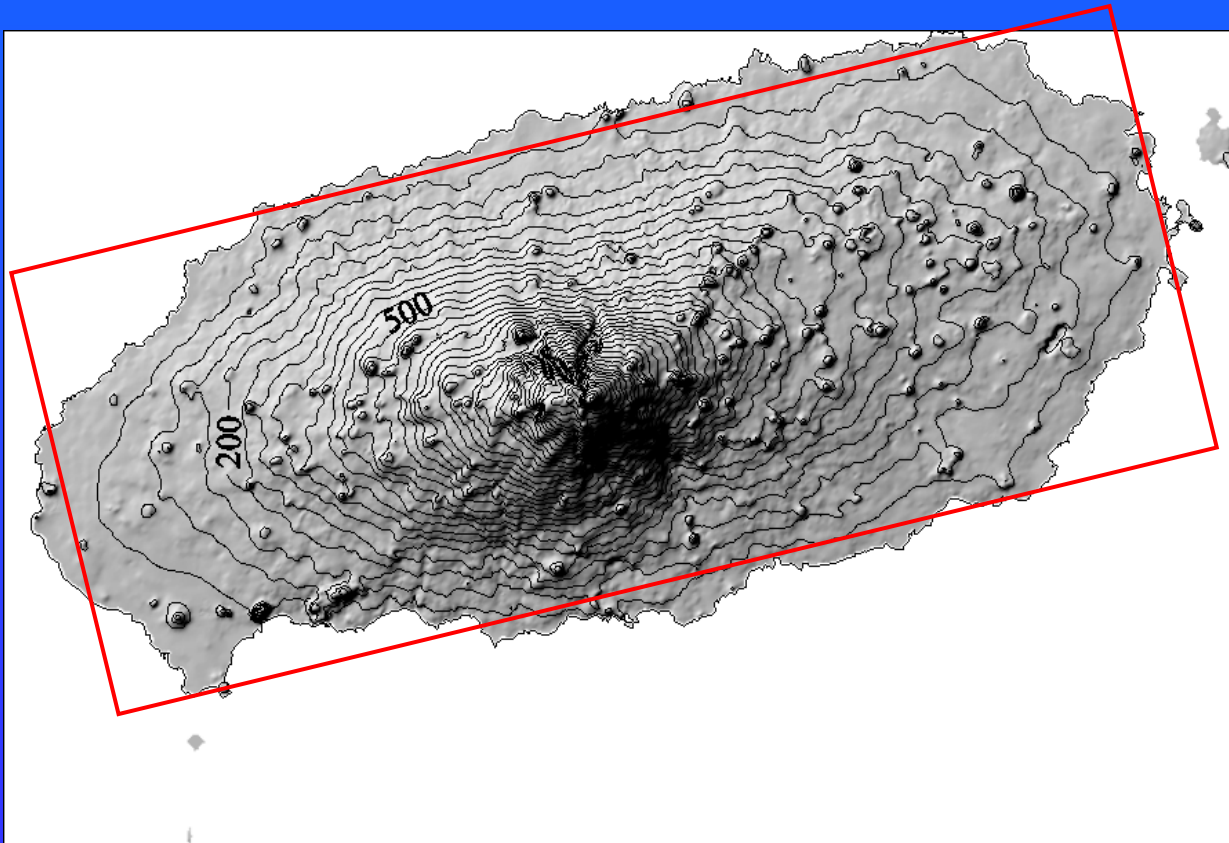
For Jeju Island? (Future works)

1. Fixing resistivity of each inversion blocks for the sea water



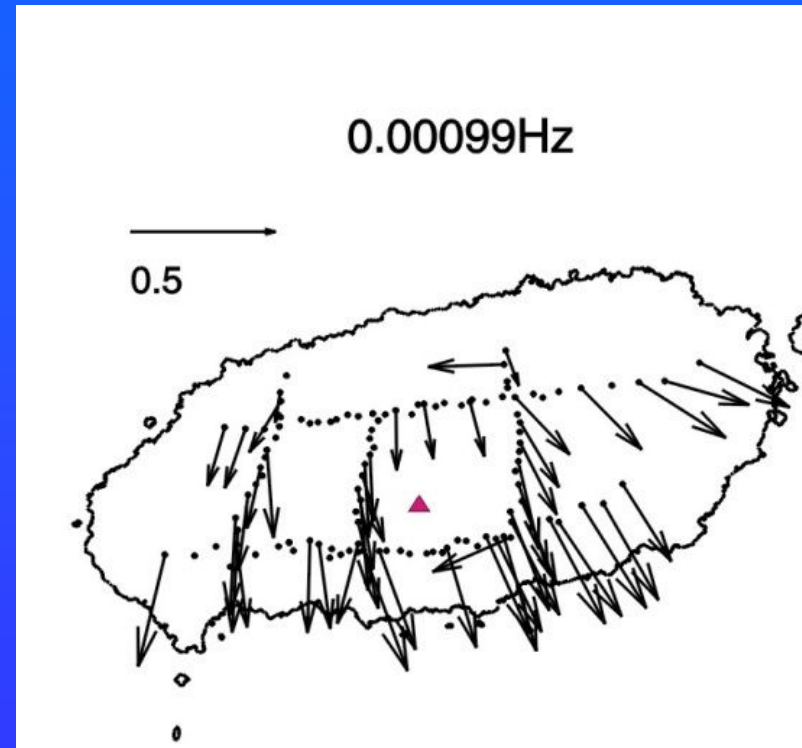
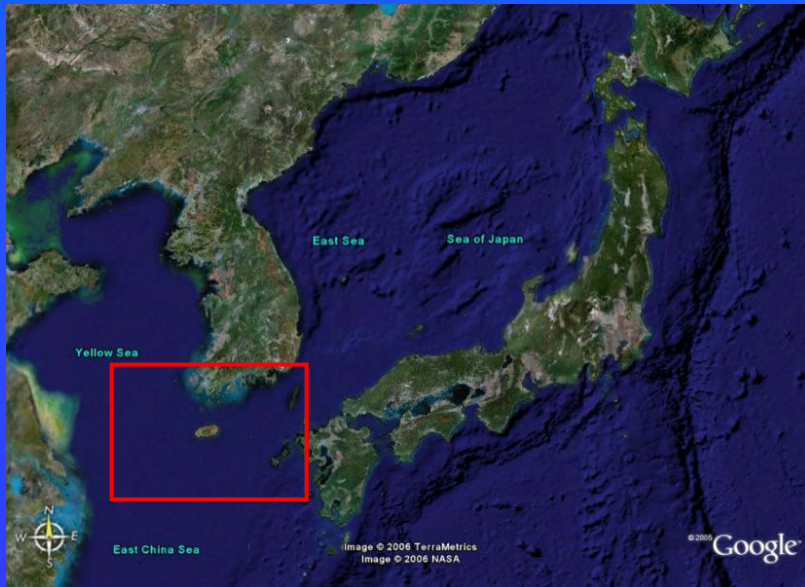
For Jeju Island? (Future works)

2. Impedance rotation and Simplifying the coast line (-30 degree)



For Jeju Island? (Future works)

3. Boundary Condition



Acknowledgment

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