MARINE MINERAL EXPLORATION

Presented By

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Why?

Mineral resources on land are increasingly exhausted, however, in marine environments, sulfide ore deposits, often accompanied by seafloor hydrothermal systems have been regarded as submarine mineral resources to be explored and mined .

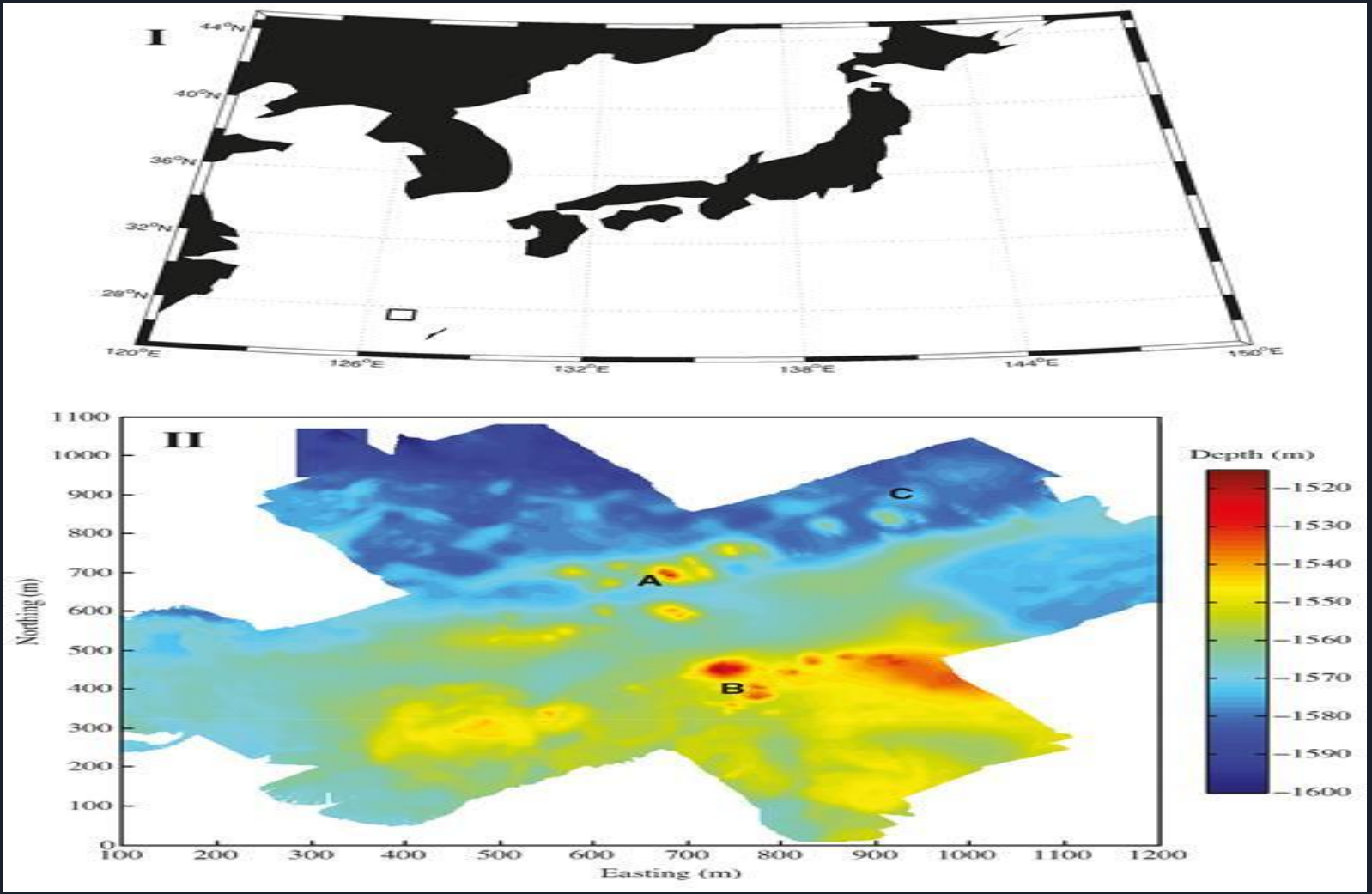
Objective

Using self potential method for studying the geology and the metalliferous ore bodies .

Geology

Location - Iheya Minor Ridge in the Iheya prospect of the Okinawa trough

Water depth - 1500m


I
44°N
40°N
36°N
32°N
28°N
120°E
126°E
132°E
138°E
144°E
150°E
II
Northing (m)
Easting (m)
A
B
C
Depth (m)
1520
1530
1540
1550
1560
1570
1580
1590
1600

DATA Collection

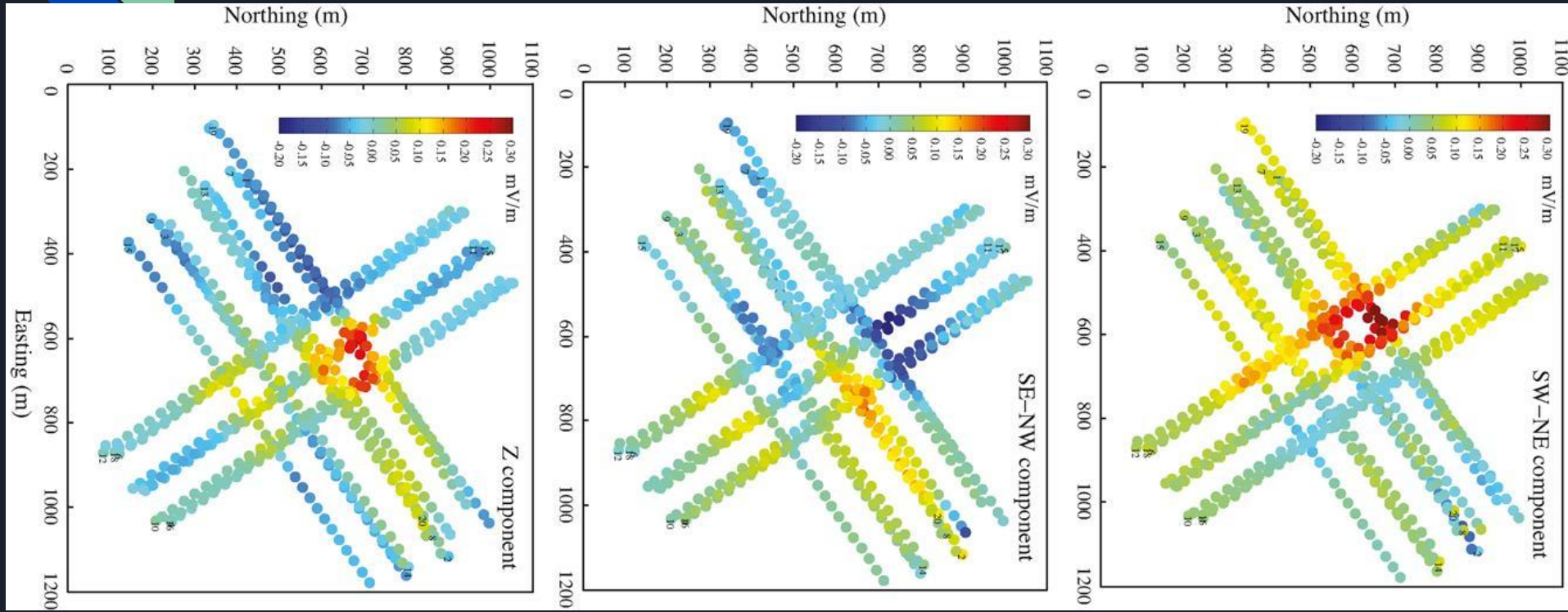
Data were collected during one 9.5 hr dive of the AUV. 20 lines each approximately 1 km long were run across the prospect, taking 7 hr. The AUV target altitude was 70 m and the vehicle speed was 1.1 m s−1, limited by the drag of the electric field dipoles. The plan was to survey three lines spaced about 100 m apart in each of two orthogonal directions, repeating the pattern until the end of the dive to determine repeatability of the data. However, on the third pass the inertial navigation slipped by about 100 m, which offset lines 13, 14 and 15 and required resurveying one line (line 19) and thus provided a slightly richer data set. Eight channels of AC and DC electric field data were sampled at 250 Hz, synchronized to GPS time before and after deployment

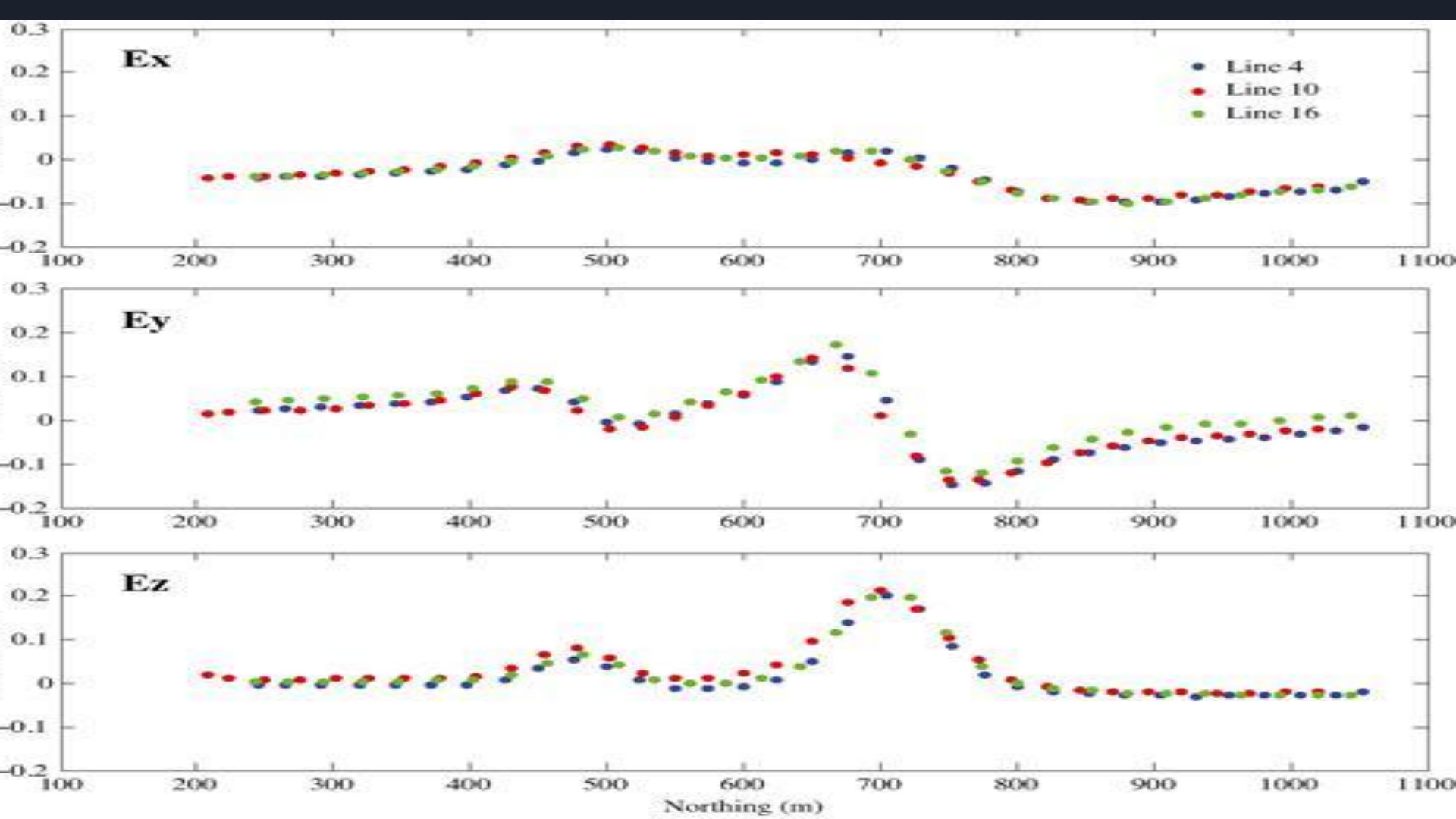

AUV
E6
E3
E5
E1
E4
E2

DATA Processing

Data processing consisted simply of averaging 30 s windows of electric field data, dividing by dipole length, and merging with AUV navigation. Standard errors in the mean were computed for the averages, which varied between 0.1 and 5μV m−1. However, these error estimates are highly structured and clearly represent spatial variations in the electric field over the 30 s averages, during which time the AUV travelled 33 m. Signal on the DC channels at low frequencies had a red spectrum from about 5 × 10−7 V Hz−1/2 at 1 Hz to about 3 × 10−4 V Hz−1/2 at 0.01 Hz, representing some combination of sensor noise, variations in electric field during the 15 min of time-series for which the spectrum was computed and magnetotelluric noise.A linear drift amounting to about 0.1 mV m−1 over the 7 hr data collection time was removed from the data. After drift removal, there are still tares of up to 0.1 mV m−1 between line crossings and the two horizontal channels, which were levelled by manual adjustment.

Electric field data (30s average after levelling)




Ex
Ey
Ez
Line 4
Line 10
Line 16
0.3
0.2
0.1
0
−0.1
−0.2
100
200
300
400
500
600
700
800
900
1000
1100
Northing (m)

DATA Interpretation

Hydrothermal fluids emanating from seafloor vents are highly reducing compared to sea water, also leading to negative SP anomalies. Kawasumi & Chiba (2017) calculated the oxygen fugacity of hydrothermal fluids in the Iheya area to be about 10–28 Pa, which is much less than in sea water. Yamamoto (2017) measured a potential more than 600 mV lower than distal sea water in venting hydrothermal fluids at the Iheya North Aki field

The localized, near-seafloor source of the SP anomalies, as modelled for anomalies (A) and (B), is consistent with hydrothermal venting as the causative mechanism. If the source of the SP anomalies was SMS mineralization, one might expect to see a less localized and more dipolar SP signal.

CONCLUSION

We have developed a system to measure DC electric fields using an AUV. A pilot study over the Iheya prospect in the Okinawa Trough mapped three components of electric field over a 1 km × 1 km area with 7.5 hr data collection. The survey pattern was repeated three times, showing excellent repeatability between passes over similar transectshigh conductivities suggest that the anomalies are associated with seafloor mineralization, the source mechanism are more likely due to hydrothermal venting