APPENDICES:
APPENDIX I

Theory:

Very Low Frequency (VLF) radio waves:

The VLF terrestrial geophysical technique uses one or more radio transmitters between the ranges of 15 to 30 KHz. The measuring of the amplitude (and subsequently phase) relationship between the vertical (secondary) magnetic field, \( H_z \), relative to the horizontal (primary+secondary) field, \( H_y \) was initially developed as an inductive profiling technique relying on wave-field interaction with two dimensional (2D) and three-dimensional (3D) resistivity structures (Beamish, 2000; Oskooi, 2005). The plane waves, the horizontal and vertical magnetic field components (\( H_x \), \( H_y \), and \( H_z \)) which are related linearly, constitute the primary field as:

\[
H_z = AH_x + BH_y , \tag{1}
\]

where the values A, B depend on the Earth’s structure and is independent of transmitter direction (Pedersen et al., 1994; Oskooi, 2005). The components of the magnetic field being calculated by VLF instrument are the vertical and one horizontal. The x-axis is supposed to be if possible the direction to the transmitter being used which indicates the geological strike orientation, while the y-axis is the measured profile direction. For each site, the transfer function, the so-called scalar tipper, \( B_{sca} \), is estimated:

\[
H_z = BH_y , \tag{2}
\]

Only when A=0 is the tipper B equal to \( B_{sca} \). The dominant gradients above conductors are revealed when in a 2D Earth; the tipper varies along the profile (Pedersen et al., 1994; Oskooi, 2005). The tipper is a complex quantity with real and imaginary parts, as in a known frequency, the horizontal and vertical fields normally have a time lag due to the underlying electromagnetic induction process in the Earth. The vertical magnetic field is totally of secondary origin, as the horizontal magnetic field combines the primary and the secondary field which were produced through induction.
The measuring of the amplitude (and subsequently phase) relationship between the vertical (secondary) magnetic field, $H_z$, relative to the horizontal (primary+secondary) field, $H_y$ was initially developed as an inductive profiling technique relying on wave-field interaction with two dimensional (2D) and three-dimensional (3D) resistivity structures (Beamish, 2000; Oskooi, 2005).

**Compass gradient masks in various directions:**

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<tr>
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**Laplacian filters that can be applied to satellite imagery for edge enhancement performance:**

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<table>
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<td>1 1 1</td>
<td>0 -1 0</td>
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The Prewitt and Sobel edge detector operators:

<table>
<thead>
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<th>Prewitt horizontal</th>
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<th>Prewitt vertical</th>
<th>Sobel vertical</th>
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<td>1 0 -1</td>
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Theory formulas:

i) OIF
- The expression of OIF is:

\[
OIF = \frac{(s_R + s_G + s_B)}{(\text{abs}_{RG} + \text{abs}_{RB} + \text{abs}_{GB})}
\]

Where:
- \( s_R, s_G, \) and \( s_B \): Standard deviation of selected bands for RGB color combination.
- \( \text{abs}_{RG}, \text{abs}_{RB}, \) and \( \text{abs}_{GB} \): Absolute value of the correlation coefficients between selected bands of the RGB color combination, R and G; R and B; and G and B, respectively.

ii) ASTER and SRTM DEMs
- The steps used during the fusing of the ASTER and SRTM DEMs are:
  - Step 1: Fill in voids in SRTM DEM using ASTER ER Mapper 7.1 formula applied:

\[
\text{If (i1 = -32768) then i2 else i1}
\]

Where i1 = ASTER DEM
Where i2 = SRTM DEM
Where -32768 is the SRTM No Data value.
• Step 2: Use improved SRTM DEM to remove artefacts in ASTER DEM

ER Mapper 7.1 formula applied:

If i1 = 0 then i2 else if abs(i1 - i2) > 0 then i2 else (i1+i2)/2
Where i1 = ASTER DEM
Where i2 = Improved SRTM DEM
Where 0 is the no data value in the ASTER DEM mosaic

• Step 3: fill in remaining voids using interpolated SRTM DEM layer

ArcMap 9.1 formula applied

con(isnull(original_grid), interpolated_grid, original_grid)
Where original_grid is the DEM with null data holes
Where interpolated_grid is the interpolated SRTM DEM made using SRTMFill

The fused DEM contained data from the SRTM DEM which filled in the missing data from cloud covered parts of the ASTER DEM. The gaps in the ASTER DEM caused by cloud cover were creating a void with decreasing values acquired by the neighbor cell values. The threshold value in the formula needs to be zero so only those regions to be filled with SRTM DEM information. Higher threshold value provided a fused DEM where SRTM DEM resulted to fill part of the valleys. Due to that fact the masking of the cloud coverage was determined so that masked regions were defined by zero data values.

iii) Topographic Wetness Index

The calculation of the topographic wetness index (TWI) was defined as:

TWI = ln (a/tanb),
where a is the upslope contributing area calculated with the D-inf algorithm described in Tarboton (1997) and tanb is the local slope.
Appendix II:

![Graphs showing the relationship between the number of streams (Nu) and the order of streams (u) for different locations: Metoxi, Balsamakia, Maggestra, Kastelli, Milas, Tifios.](image-url)
Appendix II

[Graphs showing the number of streams (Nu) against the order of streams (u) for different locations: Sfakiano Gorge, Therisiano Gorge, Pelekaniotis, Kalamis, Xairepotamos, Kakodkianos.]
Fig. 1: The plots of the number of streams to their order for the drainage basins of the Chania prefecture and the deviation observed in some of them as a result of variation in relief, probably due to tectonic factors.
Fig. 2: Digitized map with the classification of geological formations with regard to their permeability.
**Fig. 3:** Stream ordering map of Kakodikianos drainage basin based on Strahler’s system.

**Fig. 4:** Hydrographic classification of Kakodikianos drainage basin based on Strahler’s system.
Fig. 5: A sample of Vf profile extracted from DEMs, depicting the V-shaped valley occurring for low values of Vf index, implying tectonic activity and U-shaped valley occurring for high values, implying no tectonic activity.
Fig. 6: Sample of the hypsometric curves (HC) of drainage basins with the fluctuations along the curve, indicating depositional surfaces (alluvial fans) or knickpoints (uplift). Lithology across the basins is depicted to make more meaningful these observed fluctuations.
Fig. 7: Study region with stream frequency values (beige/light brown = low values; dark brown = high values), overlain with a lineament map. Lineaments in red colour characterize lineaments/faults that bound zones of high stream frequency values.
<table>
<thead>
<tr>
<th></th>
<th>Aradaina Gorge 1st order</th>
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<th>Aradaina 3rd order</th>
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<tr>
<td>Pelekaniotis</td>
<td>Pelekaniotis 1st order</td>
<td>Pelekaniotis 2nd order</td>
<td>Pelekaniotis 3rd order</td>
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<tr>
<td>Potamos</td>
<td>Potamos 1st order</td>
<td>Potamos 2nd order</td>
<td>Potamos 3rd order</td>
</tr>
</tbody>
</table>
Fig. 8 a: The rose diagrams of drainage basins stream network and individually rose diagrams of the 1st, 2nd, 3rd ordering stream network.
Fig. 8 b: The rose diagrams of faults azimuth for each drainage basin
Fig. 9: The images of the sixth principal components of Landsat ETM+ for the investigated area.
Appendix II

Fig. 10: The extracted Landsat ETM+ images after the maximum noise fraction application.
Appendix II
Appendix II
Appendix II
Fig. 11: Sample site selected to represent the outcomes of compass gradient masks, Laplacian filter and non-directional filters (Sobel and Prewitt) applied in Landsat ETM+ TM7 and second principal component of Landsat ETM+ sensors.
Fig. 12: The shaded reliefs of DEMs for various azimuths and sun elevation.
Appendix II

Profile: 3525E (20.9 kHz)

Filtered data, depth = 20

- Real
- Imaginary
Appendix II
Profile: 3517E (20.9 kHz)

Filtered data, depth= 20

- Real
  o Imaginary
Appendix II
Appendix II

Profile: 3518E (23.4 kHz)  3518

Filtered data, depth = 20

- Real
  o Imaginary
Appendix II
Appendix II
Appendix II
Appendix II

Profile: 3516E (20.9 kHz)  3516

Filtered data, depth= 20

- Real
o Imaginary
Appendix II

Profile: 3526E (20.9 kHz)

Filtered data, depth = 20

- Real
- Imaginary
Appendix II
Appendix II

Profile: 4000E (20.9 kHz)  4000

Filtered data, depth = 20

- Real
o Imaginary
Appendix II
Appendix II

Profile: 4001E    4001

200N  300N

50

Real

imag
Appendix II
Appendix II
Appendix II

Profile: 4005E (20.9 kHz)  4005

Filtered data, depth = 20

- Real

- Imaginary
Appendix II
Appendix II

Profile: 4006E (23.4 kHz) 4006

Filtered data, depth: 20

- Real
- Imaginary
Appendix II
Appendix II
Appendix II
Appendix II
Appendix II

Profile: 4000E (20.9 kHz)  4000

Filtered data, depth = 20

- Real
- Imaginary

AII.63
Appendix II
Appendix II

Profile: 4100E (23.4 kHz)  4009

Filtered data, depth= 20

- Real
- Imaginary
Appendix II

Profile: 4010E (23.4 kHz) 4010

Filtered data, depth = 20

- Real
  o Imaginary
Appendix II

Profile: 4011E (23.4 kHz)  4011

Filtered data, depth = 10

- Real
- Imaginary
Appendix II

Profile: 4012E (20.9 kHz) 4012

Filtered data, depth = 20

- Real
- Imaginary

AII.72
Appendix II
Appendix II

Profile: 4013E (20.9 kHz) 4013

Filtered data, depth = 20

- Real
  o Imaginary
Appendix II
Appendix II
Appendix II

**Fig. 13:** The graph plots of the two magnetic components of raw VLF data (real and imaginary part) and the interpreted identified faults (black arrows). Vertical cross sections of observed faults also performed.
Fig. 14: The figures of the rest VLF data after 2D inversion modelling with fracture zones, faults and bedrock being depicted on them. Transition from low conductivity values to high conductivity values, indicates the discrimination between fracture zones and bedrock. Longitudinal profiles were extracted utilising DEMs. The plot diagrams depict abrupt breaks of slope and faults indicated with black arrows.
APPENDIX II TABLES:

Principal Component Analysis:

- Landsat ETM+ PCA results

### Covariance

<table>
<thead>
<tr>
<th></th>
<th>Band 1</th>
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<th>Band 4</th>
<th>Band 5</th>
<th>Band 7</th>
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<td>2520.028</td>
<td>681.228</td>
<td>1993.101</td>
<td>2241.894</td>
</tr>
<tr>
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<td>2625.56</td>
<td>2564.961</td>
<td>2483.259</td>
<td>835.822</td>
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<td>2204.885</td>
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<td>2520.02</td>
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<td>2519.917</td>
<td>776.874</td>
<td>2092.431</td>
<td>2269.015</td>
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<td>776.8745</td>
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<td>1993.10</td>
<td>1994.93</td>
<td>2092.431</td>
<td>878.056</td>
<td>2197.859</td>
<td>2188.644</td>
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<td>Band 7</td>
<td>2241.89</td>
<td>2204.885</td>
<td>2269.015</td>
<td>644.835</td>
<td>2188.644</td>
<td>2347.826</td>
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**Table 1:** The covariance values per each spectrum band of the Landsat ETM+ multispectral imagery.

### Correlation

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<th>Band 7</th>
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<td>0.292</td>
<td>0.795</td>
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<td>Band 2</td>
<td>0.969</td>
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<td>0.379</td>
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**Table 2:** The correlation values per each spectrum band of the Landsat ETM+ multispectral imagery.
Appendix II

Eigenmatrix

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Table 3: The eigenvectors of the principal component analysis of the Landsat ETM+ multispectral imagery, with higher values making the bands representative of the principal component.

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Table 4: Best OIF false colour composites combination for Landsat ETM+.
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