Acquisition and Processing
Of a Detailed Aeromagnetic Survey
Maui, Hawaii

For

Ormat Nevada Inc
6225 Neil Road
Reno, NV 89511

EDCON-PRJ, Inc.
171 S. Van Gordon St – Ste E
Denver, Colorado 80228
303-980-6556
www.edcon-prj.com
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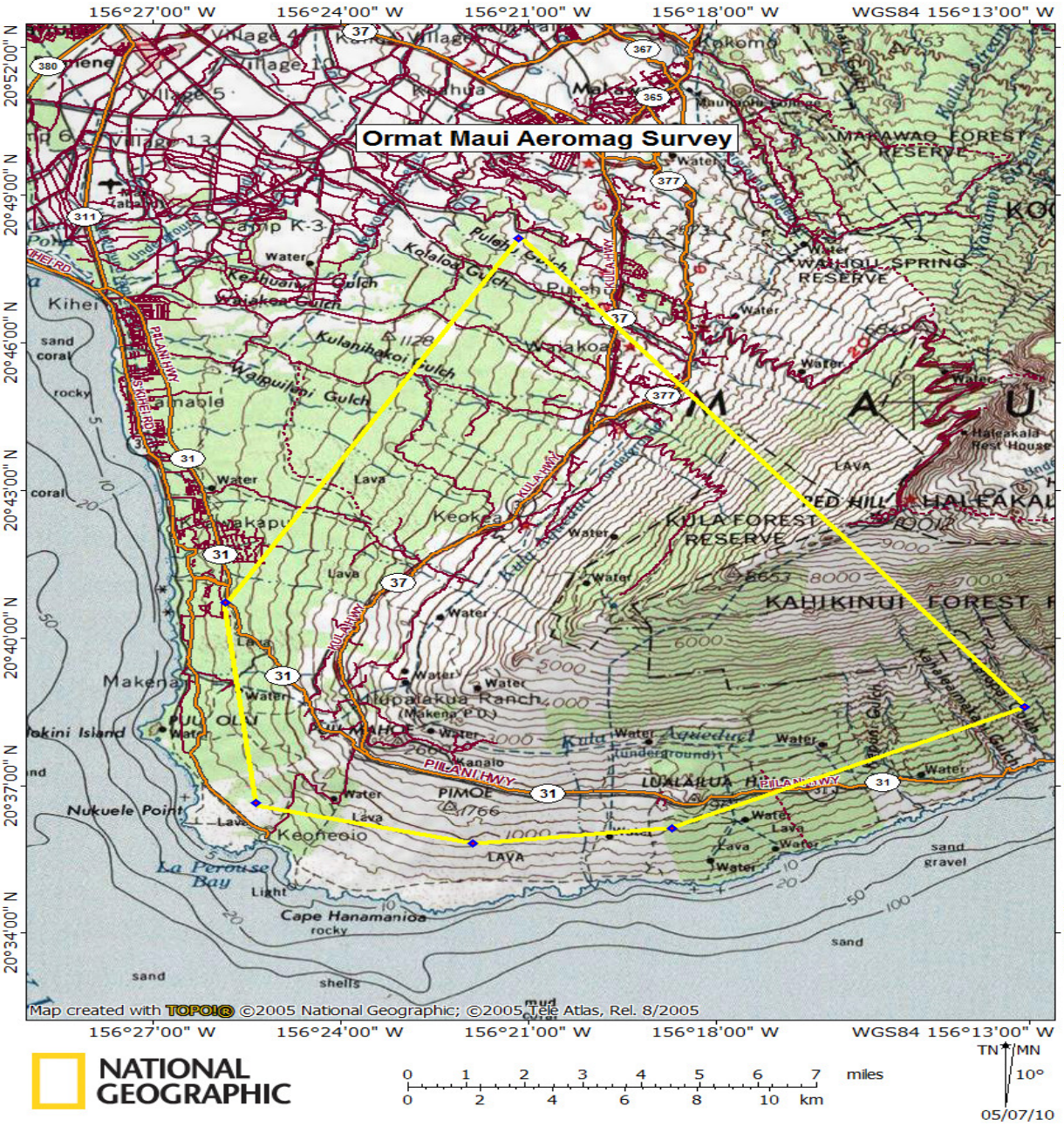
Summary

Using an helicopter and a towed sensor array, a high-resolution aeromagnetic survey was carried out over Ormat Nevada's area of interest in Maui, Hawaii.

Survey Outline



Primary survey lines were spaced at 250-meter intervals with a tie-line spacing of 1250 meters. Terrain clearance of the sensor averaged 401 meters.

A total of 783 line miles (1253 line kilometers) of aeromagnetic data were acquired. Survey operations were completed on April 17, 2010.

Survey Equipment

Aircraft

Aircraft: Hughes 500D Helicopter chartered from Windward Aviation, Kahului, Maui
Pilot: Don Shearer, Owner, Windward Aviation
Data Acquisition: Michael Hobbs
Geometrics 823A Magnetometer (Primary magnetic sensor)

- Recording interval: 0.1 sec
- Sensitivity: 0.01 nT
- Maximum accepted noise level: 0.25 nT peak-to-peak

Freeflight Systems TRA 3000 – Radar Altimeter

- Recording interval: 0.1 sec
- Digital recording resolution, 0.25 ft

Trimble AgGPS 150 Guidance System

- Recording interval: 0.2 sec

Panasonic Toughbook Laptop computer with digital data acquisition system

Ground Base Station

Geometrics 856AX Magnetometer (Base Station)

- Recording interval: 0.5 seconds
- Time synchronized to airborne system
- Recording resolution: 0.1 nT

Production Summary

An aeromagnetic survey was conducted over portions of the island of Maui for Ormat Nevada by EDCON-PRJ of Lakewood, Colorado on April 17 – 22 of 2010. Approximately 1400 line kilometers of data acquisition were obtained in 11 sorties over five days of flying.

The flight line spacing was 250m, and two sets of flight lines were flown in order to maintain survey operations at constant elevations as much as possible. The survey area included portions of the Haleakala volcano which rises from sea level to over 10,000 feet within the survey boundaries. The two sets of flight lines, at headings of 30° TN and 260° TN, intersected at the middle of the survey area. The tie lines were flown at 1250m and headings of 140° TN. The AGL elevation of the towed sensor was maintained at 400m . The sensor was suspended approximately 25m below the aircraft on a nylon bridle.

Towed sensors cannot, by FAA statute, be flown over occupied structures. As a result, lines in several portions of the survey area had to be diverted or eliminated. A Google Earth image of the survey area with the completed survey lines is included here showing areas avoided due to villages and housing developments. In general, these population centers were encountered in the northern portion of the survey, out of Ormat's primary area of interest.

DATA PROCESSING

A. Flight Path Recovery

The DGPS navigation vertical and horizontal coordinate outputs were recorded as latitude, longitude, and elevation using the WGS84 geographic coordinate system. Mapping parameters for processed digital and mapped data are shown below.

Projection Information:

Projection:	UTM, Zone 4
Ellipsoid:	Clarke 1866
Datum:	NAD 27

A speed check on the location data was completed, and the line location with the derived aircraft speed information was mapped for editing. After editing, the GPS data were accepted for the final flight-path map production.

B. Magnetic Data

1. Preliminary Processing and Data Editing

a. Digital magnetic and navigation data were transmitted from the field to EDCON-PRJ's data site for daily evaluation and verification.
b. Profile plots of the magnetic data for each line were inspected for noisy or missing data.
c. The data quality was good, and no filters were applied.
d. No de-culturing of the data was attempted. Magnetometer dropouts were identified and removed from the data. The data gaps were interpolated.

4. I.G.R.F.

The International Geomagnetic Reference Field (IGRF 2010), updated to the dates of the survey, was calculated and applied to the dataset.

5. Diurnal Correction

The base magnetometer data were inspected and compared with the observed magnetic data trace.

The following diurnal correction, in addition to the removal of diurnal by the line adjustment procedures, was applied to the dataset:

The observed diurnal, corrected for the I.G.R.F. values for the location of the base station, were hi-cut filtered to remove noise and subtracted from the observed magnetic data.

6. *Leveling*

Mis-ties at line intersections were calculated and adjusted to minimize mis-tie errors. Initial leveling adjustments were completed using a DC level adjustment to compensate for long wavelength diurnal effects. The average intersection mis-tie before DC adjustment was 45.1 nT; after DC adjustment, the average mis-tie was 13.17 nT, the mis-tie after final leveling was 0.1 nT.

7. *Reduction to the Pole*

Reduction-to-the pole calculates the field that would be observed if the survey area were located at the north magnetic pole. This transformation shifts the magnetic anomalies more nearly over the causative bodies. The reduced-to-pole grid was calculated using an inclination of 37.37 degrees and a declination of 9.9 degrees.

III. DELIVERABLES

The following were delivered as part of the project:

A. Maps as PDF on CD ROM

1. Maui_tmi.pdf: Total Magnetic Intensity Map.
2. Maui_rtp.pdf: Reduced To Pole (TMI) Map.
3. Maui_hg.pdf: Horizontal Gradient (RTP) Map.
4. Maui_tilt.pdf: Tilt Derivative (RTP) Map.
5. Maui_hgtilt.pdf: HG of the Tilt Derivative Map.

B. Digital Data

- Maui_tmi.xyz: Total Magnetic Intensity Grid in XYZ Grid Format
- Maui_rtp.xyz: Reduced To Pole (TMI) Grid in XYZ Grid Format
- Maui_hg.xyz: Horizontal Gradient (RTP) Grid in XYZ Grid Format
- Maui_tilt.xyz: Tilt Derivative (RTP) Grid in XYZ Grid Format
- Maui_hgtilt.xyz: HG of the Tilt Derivative Grid in XYZ Grid Format
- Maui.dat: Survey line data in ASCII Format

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Survey Line Data Format

Columns	Format	Description	Units
1-8	A8	Line Name	Alpha
9-20	F12.5	Latitude	Decimal Degrees
21-32	F12.5	Longitude	Decimal Degrees
33-43	F11.1	UTM X	Meters
44-54	F11.1	UTM Y	Meters
55-65	F9.0	Fid	
66-72	F7.1	Radar Altimeter	Feet
73-80	F8.1	GPS Elevation	Feet
81-89	F9.2	Raw Magnetics	nT
90-98	F9.2	Final Magnetics	nT
99-107	F9.2	Diurnal Magnetics	nT

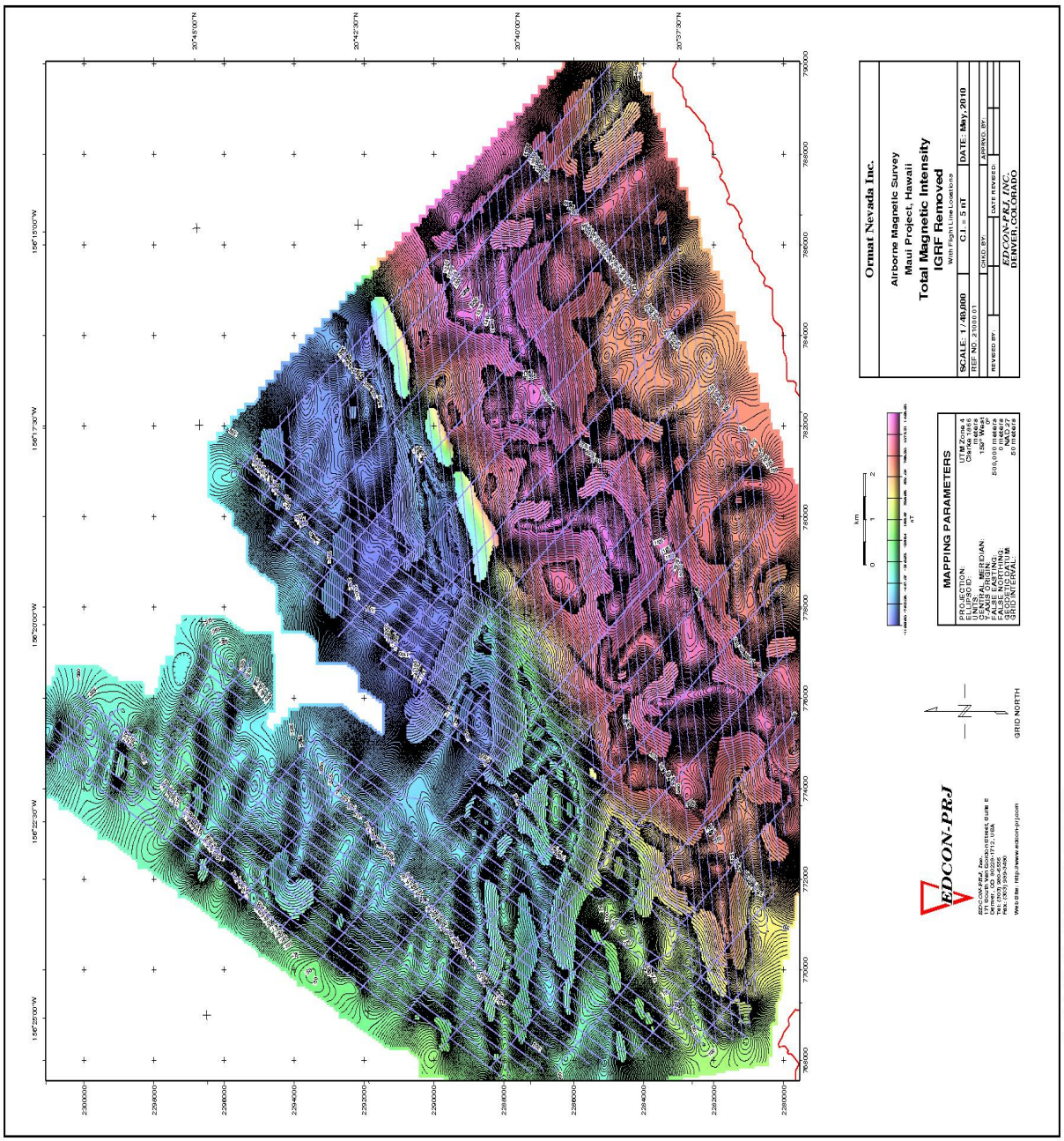

Figure1: Total Magnetic Intensity Map