MAPPING INDUCED POLARIZATION WITH NATURAL ELECTROMAGNETIC FIELDS FOR EXPLORATION AND RESOURCES CHARACTERIZATION BY THE MINING INDUSTRY

Abstract

In this first quarter we made an organizational change in the project that should allow us to more easily meet the project milestones. This change consists of designing a new systems that will allow to simplify field operation and reduce survey costs. The new system design has been completed and we are in the process of completing the manufacture and test of the first prototype. Production of the final system for the survey shoul be completed by end of July.

The new acquisition and processing software is in progress and will be ready by the end of July. The new processing software will include the robust processing developed by Larsen and Egbert.

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1. Objective

The objectives of this project is to demonstrate the use of a new geophysical system to collect economically competitive induced polarization (IP) data using natural electromagnetic (EM) field as a source.

The proposed technology uses naturally-existing EM fields, which provides greater depth of exploration and significant economic, energy, environmental and safety benefits.

2. Project Description

The purpose of this project is to use a new geophysical field system, designed to efficiently collect EM data along a profile line, to obtain IP data using natural EM fields as the source. The technique is non-invasive, eliminates the need for current electrodes and motor generator sets, and provides greater depth of exploration than controlled-source IP surveys. During the course of the project we will complete the adaption of a new field system for natural IP data collection, determine the procedures for its efficient deployment, and demonstrate the usefulness of natural IP.

3. Summary of Progress

In this first quarter we made an organizational change in the project that should allow us to more easily meet the project milestones. This change consists of designing a new systems that will allow to simplify field operation and reduce survey costs. The new system design has been completed and we are in the process of completing the manufacture and test of the first prototype. Production of the final system for the survey shoul be completed by end of July.

The new system has been designed in order to achieve the following goals:
1) low power consumption
2) low weigth
3) low cost field operation
4) low cost of equipment manufacture

3.1 Hardware design

Following are the specifications of the new system (MT-24/LF)

a. Storage flash EPROM with minimum capacity of 192Mbyte per 24 bit channel.

b. 24 bit analog to digital (A/D) converter.

c. Six (6) channels with 24 bit resolution and two (2) with a 16 bit resolution are required.

d. 32 bit controller is required.

e. A precision clock with minimum accuracy of 5×10^{-8} correctable for drift to 0.1 s/yr..

f. A fast data retrieval system.

g. The data acquisition logging system includes the software necessary to acquire the data, store the data in the flash EPROM, check the proper functioning of all hardware components, and format and retrieve the data for external storage.

h. Battery life: The logging system battery has a minimum seven (7) days life, before recharging.

3.2 Software design

3.2.1 Data logging system data acquisition software

The basic software to collect, store, process data is applied within the **MT24/LF** using the computer that is an integral part of the data logging system. This software has been developed in assembly language and in C/C++ and perform the following tasks:

a)   Clock synchronization and timing

b)   Setting of digital signal filters/amplifiers

c)   Input/output control

d)   Self testing/calibration

e)   Signal averaging

f)   Control the data acquisition in the **MT24/LF** CPU

g)   Provide calibration corrections and data storage

h)   Read and store the compass and tiltmeter readings

i)   Test proper functioning of all hardware components

3.2.2 Firmware

MMT1.1 program is stored in the nonvolatile flash memory of the system. This program configures the system hardware, launches acquisition, and interfaces with an external PC via RS232 and LPT ports and to an external GPS for time synchronization.

Optional acquisition control is available using any ASCII serial port program that supports RS232 devices. For example we have used HyperTerminal supplied by Microsoft as well as an application program (COM) supplied by Persistor (CF1 CPU manufacturer). The system supports any RS232 device such as a Palm Pilot with RS232 support to control the system.

Three data acquisition modes are available on the firmware:

- *INTERACTIVE MANUAL MODE*

At the firmware prompt a set of commands are available to configure and independently trigger acquisition with the low speed A/D and the high speed A/D. For example a high frequency acquisition can be launched while the low frequency A/D are continuously collecting data. All acquisition events are executed as background interrupt driven events. This feature provides continuous support to the RS232 for housekeeping and diagnostic checks. For example, at any time the drift of the internal clock to GPS can be determined. This mode is used for bench diagnostic, troubleshooting and for manually synchronized events.

- *Scheduled Acquisition (Manual Launch)*

A specific command is available at the firmware prompt to load an ASCII script file (resident on the flash) which contains an acquisition schedule. Following is an example of a script file:

Band Definitions:
LSID) low speed ID, (1) Band ID (1..5), (19) start time (hr), (0) Length (hr: 0 means continuous)
HSID) high speed ID,(2) repeat rate (1) daily start (10) active length (all in hours)
(2) Band ID (1..5), (2) length in minutes, (5) start offset time in minutes

LSID   1   19   0
HSID   2   22   10
 2   4   5
 5   40   15

This script will configure the low speed AD to start collecting data (band 1) at 19:00:00 hrs, and keep recording continuously **(LSID   1   19   0)**.

High speed AD's will wake up every day at 22:00:00 (hrs) and launch acquisition bands every 2 hrs and will remain active during 10 hrs **(HSID   2   22   10)**. Each time a band 2 will start on a 5 minutes offset (at 22:05:00) and it will record for 4 minutes **(2   4   5)**,

and a band 5 will start on a 15 minutes offset (at 22:15:00) and it will record for 40 minutes **(5 40 15)**.

Once the script file is launched the acquisition is completely automatic and follows the configuration schedule. Note that the separate high and low speed hardware design is fully supported, allowing independent schedules for high and low speed acquisition. This feature provides enormous power and data saving and is one of the key features of the
new hardware design.

- *Scheduled Acquisition (Launched at Power On)*

At system boot up the firmware performs a complete self check (battery voltage, system diagnostics, clock check, etc) and attempts to synchronize with the GPS. After completion of diagnostics an acquisition schedule script is loaded and launched. Throughout the acquisition an external RS232 terminal (PC, Palm Pilot, etc) can interface with the system at any time to query status or system diagnostics. The power on feature is presently being implemented and tested.

3.2.3   MT24/LF data download

A Windows ™ based application is provided to download the recorded data through the LPT1 port. This program displayed a log list of acquisition events existing in chronological order, from which the user select those data sets that need to be downloaded. Also at this stage the book keeping information can be set (sensor calibration, header information, etc).

The output data format matches the MT-24 time series standard, plus a few added header lines with information regarding specifics of the MMT-24 operation (data ID, bit weight factor, tilt angles, etc). The existing MT-24 survey data structure (survey-site-run) has also been supported in order to use existing data processing and display programs (MTR-95, ACQ24).

Data download rate is about 6 Mbytes/min which requires around 32 minutes to download a full flash.

3.3 System testing and calibration

The layout of the PCB for the new system has been completed. By end of May the first prototype will be assembled, bench tested and characterized in the field relative to the magnetic measurements. The field characterization will be performed in a location about 100 miles east of San Francisco.

The electric measurement will be implemented during the month of June and will be characterized in the field by July.

We expect to complete production of 5 systems by end of July.

3.4 Software development.

The beta version of the new acquisition and processing software will be operational by the end of May. Characterization of the software and final commercial version will be completed by end of July.

3.5 Survey Plan

In August, in collaboration with Quantech Geoscience and with researchers from the University of California we will perform the first complete survey in Nevada.