Interpretation of Airborne Geophysical Data

The interpretative skills at SGL have been developed in numerous projects over the last three decades. The general format followed for each project is:

- **Background research**
- **Study of the geophysical data to be interpreted**
- **Data processing to enhance data**
- **Data presentation**
- **Modelling**
- **Preparation of interpretive maps and sections**
- **Documenting of conclusions**
- **Preparation of report**

At SGL we realize the importance of data interpretation in order to maximise the usefulness of airborne geophysics. For this reason, interpretation projects are carried out by experienced geophysicists, under the supervision of the management of the company. There are three main aspects of any interpretation, 1) methodology, 2) tools and 3) the interpreter, each of which are essential for the quality of the product. The following paragraphs address each of those areas.

METHODOLOGY

BACKGROUND RESEARCH

During the stage of background research of each interpretation project, all known sources of geophysical and geological information of the area of interest are investigated and reviewed. This includes a literature search, review of available seismic and well log data, other potential field surveys, remote sensing data, and other sources of information. Two main questions to be addressed during the background research are:

a) what information *is known about the magnetic basement and intra-sedimentary structures in the survey area and in the region?*

b) what is known about regional and local structures?

A review of analogous areas can also be very useful. With this information the interpreters can work from the existing data base to get the maximum value from the potential field data.

ANALYSIS OF THE DATA

Each data set has its own peculiarities. Before actually starting to interpret the data, it is worthwhile to spend some time to find out as much as possible about the data. This includes:

1) **Data acquisition**
   a) Survey parameters
      i) Flight altitude or height
      ii) Line spacing
      iii) Gap tolerances
   b) Instrumentation
   c) Navigation equipment

2) **Data compilation and processing**
   a) Editing
   b) Spike removal
   c) Filtering
   d) Levelling with control lines
   e) Other levelling (i.e. manual adjustments)
   f) Base station data
   g) Gridding algorithm
   h) Reference ellipsoid for positions
   i) Calibration of altimeter data
   j) Altitude corrections

PROCESSING TO ENHANCE THE DATA

The amount of data processing needed for a successful interpretation depends on the state of the data and the desired final products. The data processing facilities at SGL are equipped for all aspects of compilation and processing of all types of airborne geophysical data. A full suite of software is maintained in-house, for maximum flexibility and control over the final product. In addition to the normal steps of data compilation, such as those listed above, SGL also offers more specialized procedures, such as:

- **Derivative calculation**
- **Reduction to the pole or equator, calculation of analytic signal**
- **Decorrugation (micro-levelling)**
- **FFT based filters – high pass or low pass**
- **Depth slices**
- **Convolving filters – high pass or low pass**
- **Lineament enhancement**
- **Statistical evaluation of data**

SGL specializes in processing of navigation data, including enhancement by improved differential correction of Global Positioning System (GPS) data, and the optimal integration of various types of navigation instruments.

DATA PRESENTATION

Once digital line data of adequate quality are available, the data must be prepared for presentation to the user. A wide variety of presentation methods are available at SGL including the following:

- Profiles plotted versus time
- Stacked profiles of various parameters
- Profiles oriented along the flight lines
- Contour maps
- Colour maps
- Shaded relief maps
- Grey scale maps

Data can be gridded using a minimum curvature, cosine weighted average or an Akima spline gridding algorithm. The best method of presentation depends on the data set and the interpretation goals.

MODELLING

Most interpretation projects are based on modelling. At SGL we use three main modelling methods:

1) 3-D forward models
2) 2.5-D forward models
3) Euler deconvolution
4) Tilt derivative

Very often, all four are used. The Euler and Tilt methods provide a good start. They are fast and automatic, and give a quick and unbiased view of what the basement might look like. Unfortunately they are also ambiguous and subject to misrepresenting the depth to basement in some situations (i.e. near the ends of lines, over the edges of anomalies, for very low frequency anomalies, and in noisy data).

For a detailed study, we prefer forward modelling. Model parameters such as depth, size and location of buried bodies, intensity and direction of magnetization or density of each body, are estimated using the results of the background research. The 3-D modelling program is used to automatically refine the model parameters, minimizing the error between the theoretical and observed data. The 2.5-D modelling program can be used to interactively investigate complex modelling situations.

The forward modelling procedures help us to define the basement topography and structure and delineate any intra-sedimentary magnetic features.

PREPARATION OF INTERPRETIVE MAPS AND SECTIONS

During and after the modelling process, the results are analyzed and interpretive maps and sections are prepared. During this stage, going back to the modelling process is often advantageous to resolve any questions which have arisen while preparing maps or sections.

DOCUMENTING OF CONCLUSIONS

Conclusions of an interpretation project can include ideas concerning the relationship of the local features with the regional structure, the nature of magnetic basement, and the tectonic history of the area. They are the result of a synthesis of the entire project from background research to the preparation of interpretive products.

PREPARATION OF A FINAL REPORT

The report for each project explains each task in the interpretation process, and includes samples of the data, models and interpretive products and the conclusions.

TOOLS

SOFTWARE

SGL maintains a full suite of proprietary software for the compilation and processing of geophysical data. The modelling programs are partially based on work by the GSC, the USGS, and recent scientific publications. SGL employs geophysicists, physicists, mathematicians and computer scientists engaged in developing new programs and maintaining and enhancing existing software. Sander Geophysics also uses current versions of third party modelling software such as Geosoft GM-SYS 3D.

HARDWARE

The SGL computing centre is equipped with PC based work stations connected by a local area network as well as facilities for plotting colour and contour maps.

INTERPRETERS

Interpretation projects are carried out by experienced geophysicists under the supervision of the company management. The staff at SGL includes individuals with a wide range of education and experience in geophysical and geological interpretation. SGL maintains a staff of adequate size to provide high quality and timely interpretation of potential field data.