



Seismic and Mineral Exploration

- Time for a new relationship

Don Pridmore

d.pridmore@hiseis.com

Greg Turner

g.turner@hiseis.com

**Quickfire session
UNCOVER SUMMIT
Adelaide 2014**

Hon. Martin Fergusons's challenge to the “Searching the Deep Earth” Think Tank



“Deep earth exploration is the next frontier and it is a frontier that we must conquer if we are to continue to reap the economic benefits of our natural mineral wealth”

Conquering the new frontier!



Typical Solution (Drilling)

- Detect point locations of contacts and structures
- Resolution of conventional minerals geophysics degrades rapidly with depth
- Each hole tests a small area and provides limited context for further exploration
- 3 holes in 3 months
- ≈ \$300K per km

Problem (Exploration under cover)

- Map contacts and structures in 3D
- Resolution is maintained at depth
- Each 3D seismic survey screens multiple km³ and provides framework for subsequent exploration
- 10km² acquired and processed data in 3 months
- ≈\$150K/km² (0→2km⁺)
- **Cost effective!**

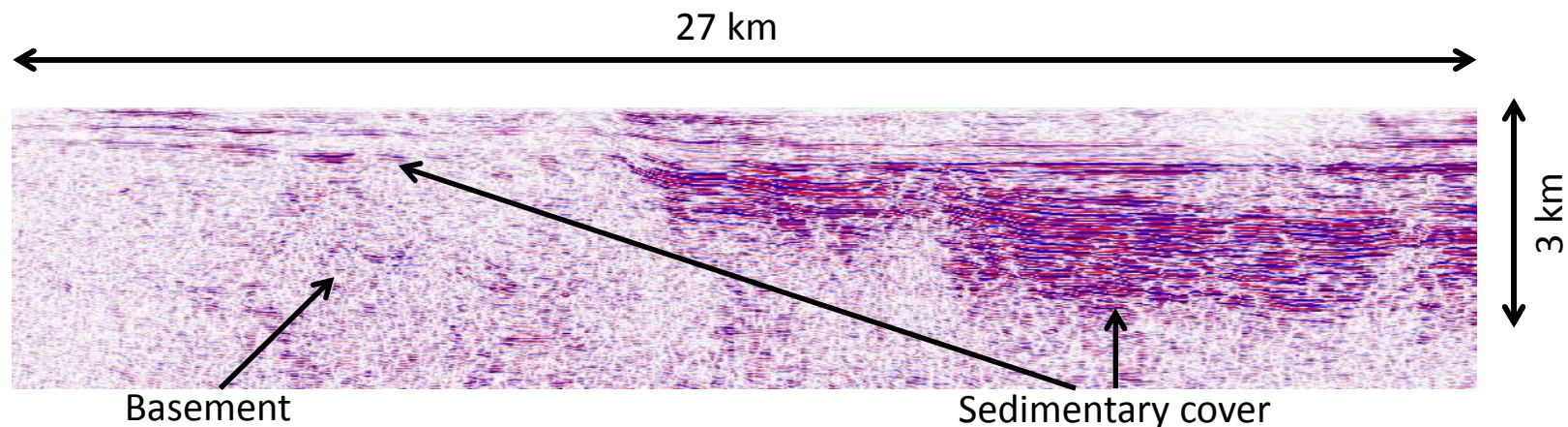
Seismic Solution (Seismic +Drilling)

Seismic Reflection – Depth of Cover



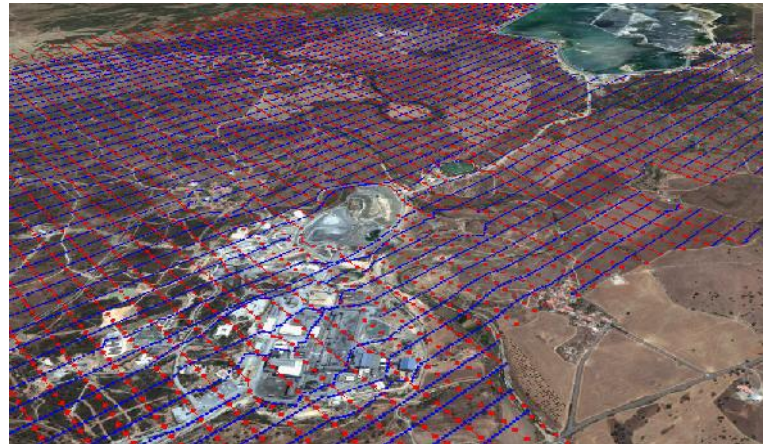
Key attributes:

- **Resolution** - Resolution of the order of 10m, maintained as a function of depth
- **Depth range** - Can map cover thickness from 10s of metres to >1km
- **Broad applicability** - Works in wide range of environments
- **Customisable** – eg LiteSeis to map cover and basement structure ~ \$3500/km



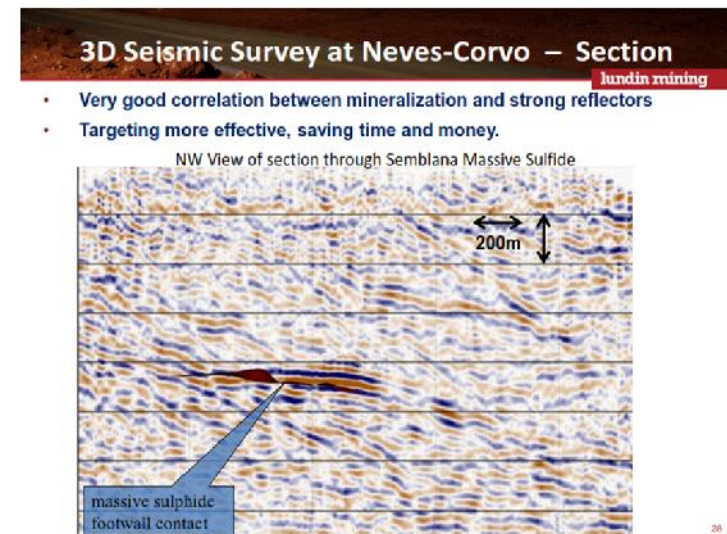
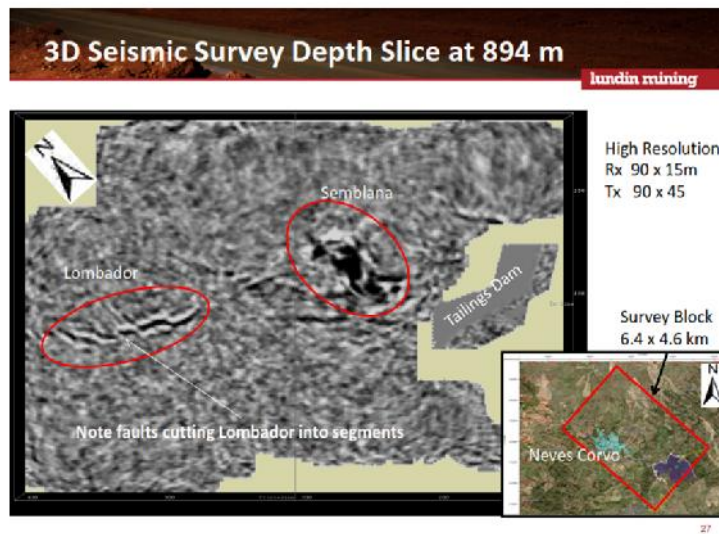
Geoscience Australia line GA_OD1 reprocessed by HiSeis

Seismic Reflection – Basement Geology



Key attributes:

- **Persistence** – Maps bedrock structure through cover and below mine infrastructure
- **Structures** – Tight spacing of measurements excellent for mapping structures
- **Direct detection** – Massive sulphides present strong seismic property contrasts to most host rocks



Seismic Reflection – Innovations



Recent innovations to reduce directional ambiguity in 2D seismic reflection data

Aleksandar Dzunic
Senior Geophysicist

Introduction

2D and 2D seismic reflection surveys are increasingly being used to 4d mineral exploration under drive because of their ability to image the subsurface over a wide range of depths and resolutions. However, the resolution is essentially maintained as a function of depth.

One of the limitations of 2D reflection surveys is their directional ambiguity. Data are usually obtained in a way that indicates that the interfaces imaged are directly below the survey line. However, reflections may be obtained from interfaces which are off to the side of the line in 2-dimensional geological environments. In more irregular environments the error can be large 2-dimensional. In contrast to many sedimentary basin environments.

A consequence of the ambiguity is the drilling option is significantly reduced on features seen in conventional 2D seismic data. Possible examples seen where holes drilled on 2D seismic data have produced results not consistent with the position of interfaces interpreted from the seismic data. An ICD 2D is used to be directly below the survey line.

HiSeis have developed a technique which we call "ICD 2D" which provides information on the 2D location of interfaces at a cost which is only ~25-30% greater than the cost of a conventional 2D survey. This provides the operator both a more definite on the seismic data and to minimize the drilling with the seismic data.

2D 2R

A 2D 2R survey is acquired in the same way as a 2D seismic survey, except that instead of having one line of receivers coincident with the source line, 2 receiver lines are deployed either side of the source line. These lines need to be offset around the area. It is a desirable time delay between reflections, depend on the true direction of the reflection is from an interface to the side of the line. In ideal environments the common offset is approximately 10m however smaller offsets may still provide sufficient discrimination.

The concept of 2D 2R is illustrated in Figures 1-7 below.

Figure 1 2D 2R in plan view shows the source line and 2 parallel receiver lines separated approximately 10m apart.

Figure 2 2D 2R in cross-section view. The figure shows how a particular view front (directional) from an off line receiver arrives first on the 2D line before it moves to further and is detected by the 2D line.

Figure 3 2D 2R in 3D view. The figure illustrates the concept on a plane that crosses the survey line. The figure shows both the vertical projection of the source and receiver lines and the line along which reflections would be obtained from the cross-line dipole reflector. The reflections are actually recorded from a position up-dip from the vertical projection of the line.

Figure 4 2D 2R view. The figure shows how a particular view front (directional) from an off line receiver arrives first on the 2D line before it moves to further and is detected by the 2D line.

Figure 5 Standard 2D section created by surveying along the line shown in Figure 4.

Figure 6 2D 2R section along a line parallel to the survey line. The green area highlights reflections from directly below the survey line. The red area highlights reflections from the side of the survey line. The blue area highlights reflections from some side of the line.

Figure 7 The 2D 2R data can be viewed along different orientations along the source line and therefore from near surface on one side to vertical and then to near surface on the other side. The seismic sections above show examples of the seismic data along these orientations. The diagrams above each seismic section illustrate the view areas from a position looking and on down the survey line. The diagrams show the view areas from the source line and the receiver lines. The accumulation of the reflector can be determined by identifying on which side the reflector appears compressed (as indicated).

3D detection from 2D surveys

Come see our poster!

For more information please contact Greg Turner
 Tel: 0487 752 783
 Email: g.turner@hi-seis.com

