Nickel exploration with 3D seismic – Lake Lefroy, Kambalda, WA

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Summary

The first experimental 2D high resolution seismic reflection was recorded in 2005 over McLeay nickel deposits, Lake Lefroy, Kambalda, Western Australia. Seismic results indicated that these deposits may have a seismic signature. The complexity of the seismic pattern also suggested that 3D seismic may be necessary for exploration of McLeay deposits. Subsequent pilot high resolution 3D seismic survey conducted in 2007 confirmed the potential of reflection seismic for exploration at this site. Finally in 2008, a 10 Km^2 high-resolution 3D seismic survey was acquired. Extreme conditions at the lake proved challenging for the application of seismic methods and required modification of the conventional seismic acquisition practice. In this paper we document and discuss acquisition and processing issues related to the specifics of the salt lake as well as the seismic signature of nickel deposits.

Introduction

Lake Lefroy, one of the most prolific nickel and gold provinces in Western Australia, has always been exceptionally challenging ground for the application of geophysical methods. The lake is covered by a salt crust, underlain by the lake mud. The lake surface is prone to flooding which is less often product of a direct rain fall, rather excessively strong wind, typical for the lake environment, could transports large quantities of water from elsewhere and produce local flooding. Such conditions pose serious problems for deployment of any electrical equipment but also for people movement over the lake. It is therefore not surprising that the first ever seismic reflection 2D test line was acquired only recently, in 2005. Previous work was restricted to the existing roads and causeways.

Encouraging seismic results obtained in 2005 opened large ground for the application of seismic methods for exploration of nickel and gold deposits underneath the lake surface. Since that time several 3D surveys were acquired directly on the lake surface. Here we show and discuss the results obtained by the first 2D and 3D tests conducted at the Lake Lefroy.

Seismic operations at Lake Lefroy

Deployment of the geophones and seismic cables across the excessively salty and muddy lake surface, prone to flooding presented a serious challenge for seismic data acquisition and integrity of the equipment. Consequently we had to keep the acquisition units and all electrical contacts off the highly conductive and corrosive lake surface. Roll-along operations were conducted with quad bikes. Very small explosive charges (60 cm of explosive cord, equivalent to about 40 g of pentonite) were placed in 80 cm deep, water filled, 25 mm PVS pipes. Despite small numbers of active channels (120) used first time for acquisition of 2D seismic line and hence relatively short offsets for hard rock environment, the resulting seismic image was encouraging (Figure 1). The general complexity and lateral variability of nickel deposits would logically require the application of 3D seismic method. However considering the logistic difficulties for the application of seismic on the salt lake and not overly convincing 2D seismic results it was decided that another test, this time 3D survey, should be acquired. In May 2007, we acquired such mini-3D seismic data which utilised an orthogonal pattern consisting of 4 receiver lines (400 seismic channels) and 10 shot lines, with 100 m line interval. Receiver increment was 10 m while shot increment was 20 m. 3D survey area size was 1000x800 m (Figure 2). Despite both in-line and x-line apertures were both short the resultant seismic images were highly encouraging (Figures 3 and 4). For the first time this inexpensive survey provided clear evidence that seismic reflection method could detect nickel deposits. Moreover strong reflections originating from the expected target zone suggested that seismic can become a method of choice for nickel exploration.

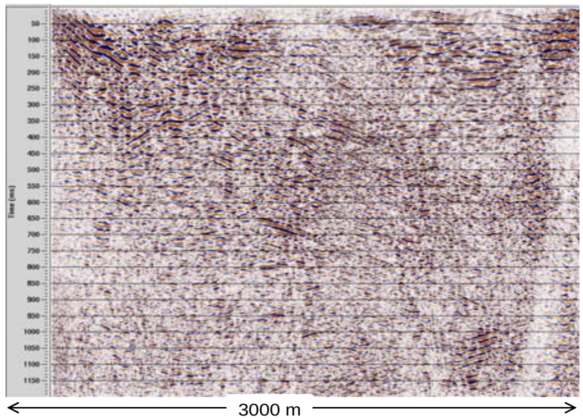

Figure 1: 2D seismic section in 2005: DMO stack, high-pass filtered.

This paper was invited by the workshop organizer and was not reviewed by the Technical Program Committee.

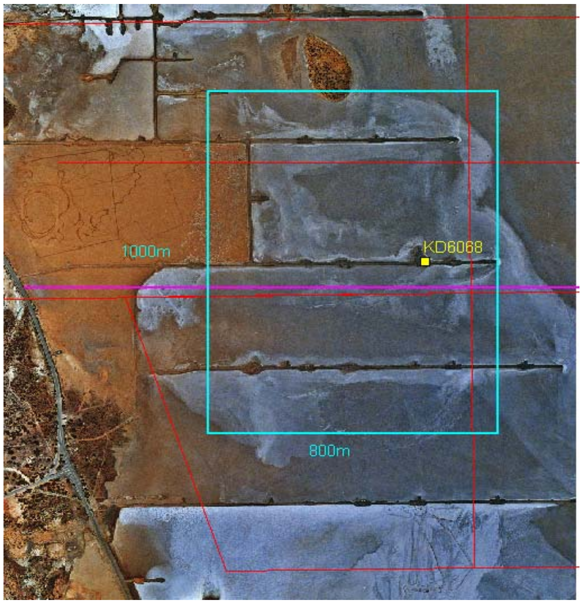

Figure 2. Initial seismic surveys over the salt lake: small 3D survey (0.8 km^2) denoted by a blue square and the first 2D seismic line (pink) ever recorded on this lake.

Consequently this year two additional 3D surveys were acquired covering in total 10 Km^2 of the prospective area.

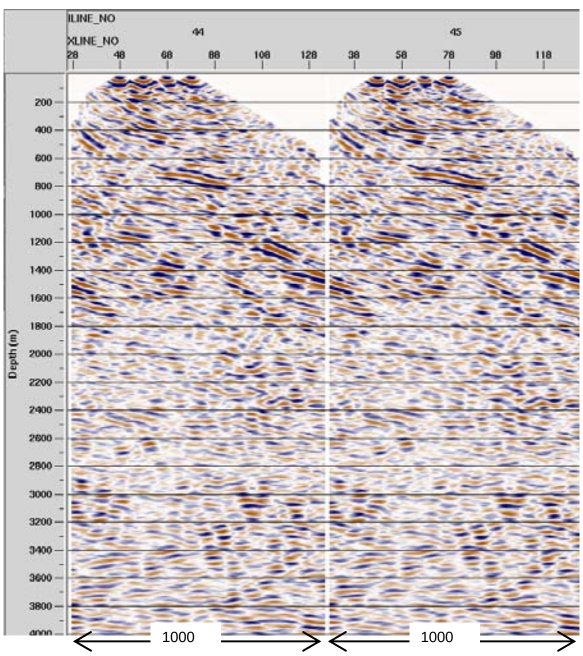

Figure 3. Pilot 3D study: inline stacks 44 and 45 converted to depth. Strong reflections at around 700 m depth correspond to the expected Nickel deposits at this site.

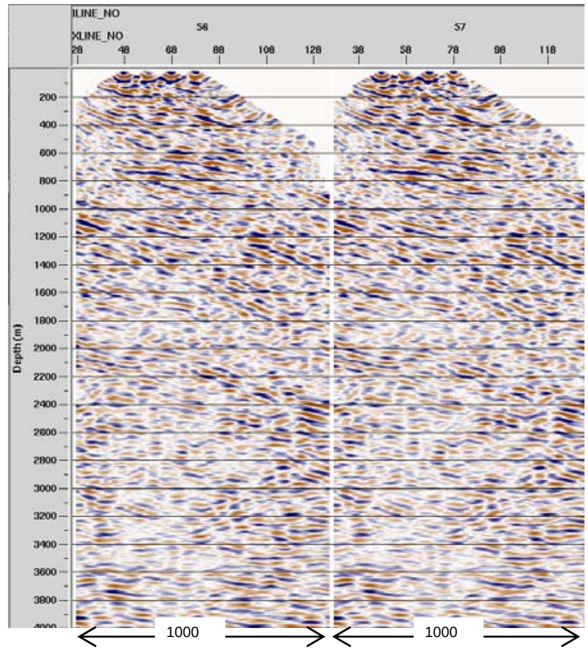

Figure 4. Pilot 3D study: inline stacks 564 and 57 converted to depth. Strong reflections at around 600 m depth correspond to the expected Nickel deposits at this site.

Conclusion

Extreme conditions at the Lake Lefroy proved challenging for the application of seismic methods and required quite different acquisition strategy. Strong wind and source generated noise caused additional difficulties for data processing. Despite this hostile environment good quality seismic images were produced that could be used to delineate nickel bearing rock units. Seismic could become a method of choice for nickel exploration in this area.

References

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