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SEISMIC REFLECTION IN THE OHAAKI-BROADLANDS GEOTHERMAL FIELD

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SUMMARY - In **1984** a seismic reflection survey was conducted over the Ohaaki-Broadlands geothermal field. The processing of the resulting data produced a very noisy result, with very few continuous reflectors, and made interpretation extremely difficult. Since then the data has been used as a proof that the seismic reflection method does not work in geothermal fields, because of the complicated geology and energy absorption and channelling in the near surface layers. At the beginning of **1996** I started to reprocess the data and found them to be much maligned. It was difficult to process and required a lot of time, but it can produce a surprisingly good quality final section that does aid in the understanding of the Ohaaki-Broadlands geothermal field. The reprocessed data shows that contrary to popular belief, the seismic reflection method that is commonly used in the Oil Industry does work in geothermal field investigations and can provide good quality data to aid the resource extraction

1 INTRODUCTION

The problems associated with acquiring reflection seismic data in the Taupo Volcanic Zone have been well documented (e.g. Bannister **1993**). This difficult acquisition environment is made even more complicated by geothermal activity. Thermal alteration of rocks and the presence of water vapour can make the acquisition and processing of seismic data, to achieve an interpretative and understandable final section almost impossible. Given this situation it is a surprise that any success has been achieved in the area at all. But most seismic results although not of a high quality have achieved reasonable results with strong continuous reflectors detected (Lamarche **1991**).

The data acquired in **1984** over the Ohaaki-Broadlands geothermal field is an example of the poor quality of data that can result from this type of environment. This data has been examined in great detail (Henrys **1987** & Henrys et al.. **1986**) and the problems clearly identified.

When I first saw the set of data obtained fiom Ohaaki-Broadlands I identified problems that I had encountered previously during the processing of seismic data for the Oil Industry, and decided that there was a potential to improve the original processing results of the data. This paper is based on the results achieved so far, and discussion of their possible consequences.

2 THE 1984 SURVEY

Six seismic reflection lines were acquired in **1984** as part of a PhD thesis (Henrys **1987**). These consisted of two lines running north-east south west parallel to the Waikato River and four lines running north-west south east, two on the west bank and two on the east bank of the river. In the reprocessing made for this study the east and west bank lines were combined which made a total of four lines (Fig 1).

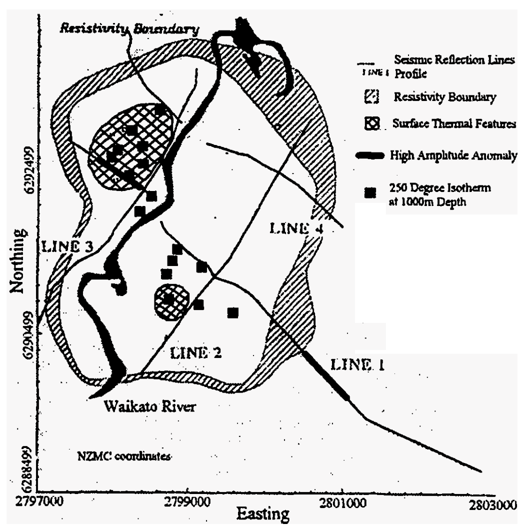

Fig 1 Map of the Ohaaki-Broadlands geothermal field, marked by low the resistivity boundary, and the seismic lines, with the area of surface thermal effects marked by cross hatch and location of seismic amplitude anomaly marked with heavy line

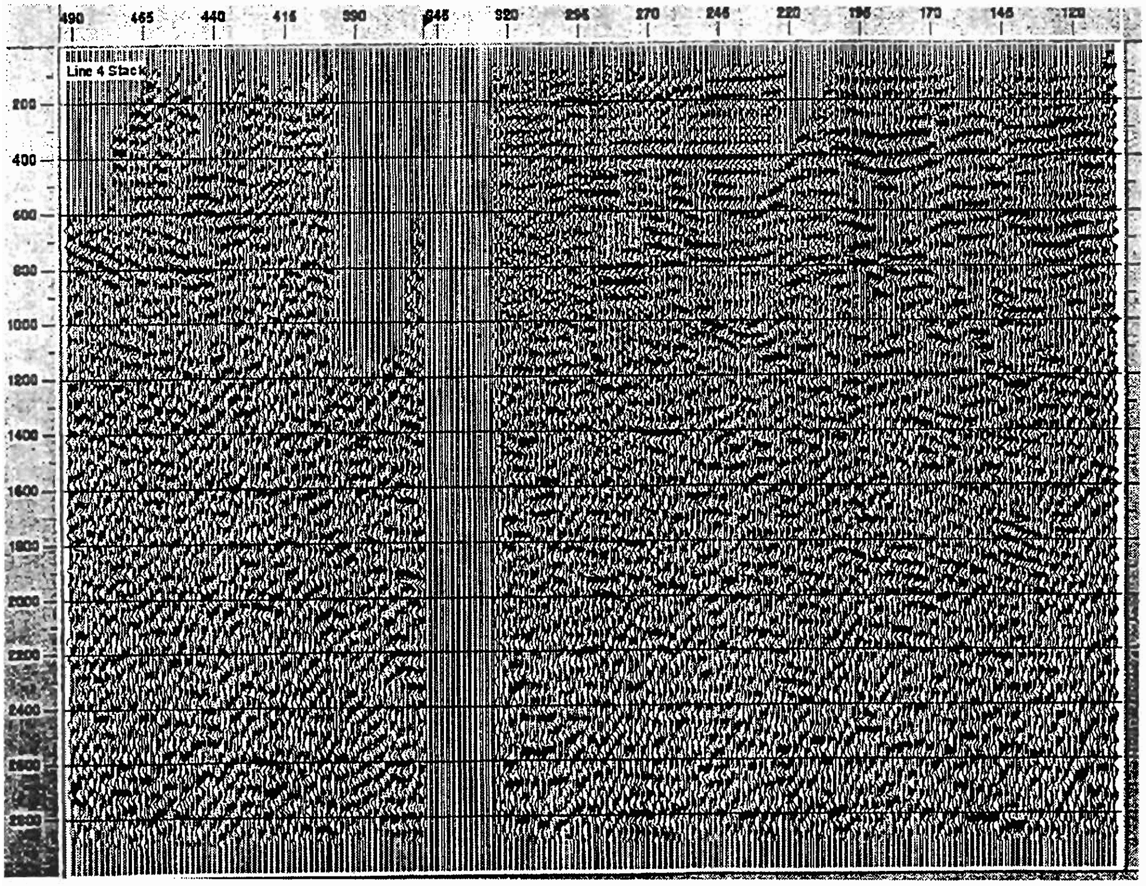

Fig 2 Provisional Final Stack Section for Line 4 Ohaaki-Broadlands geothermal field.

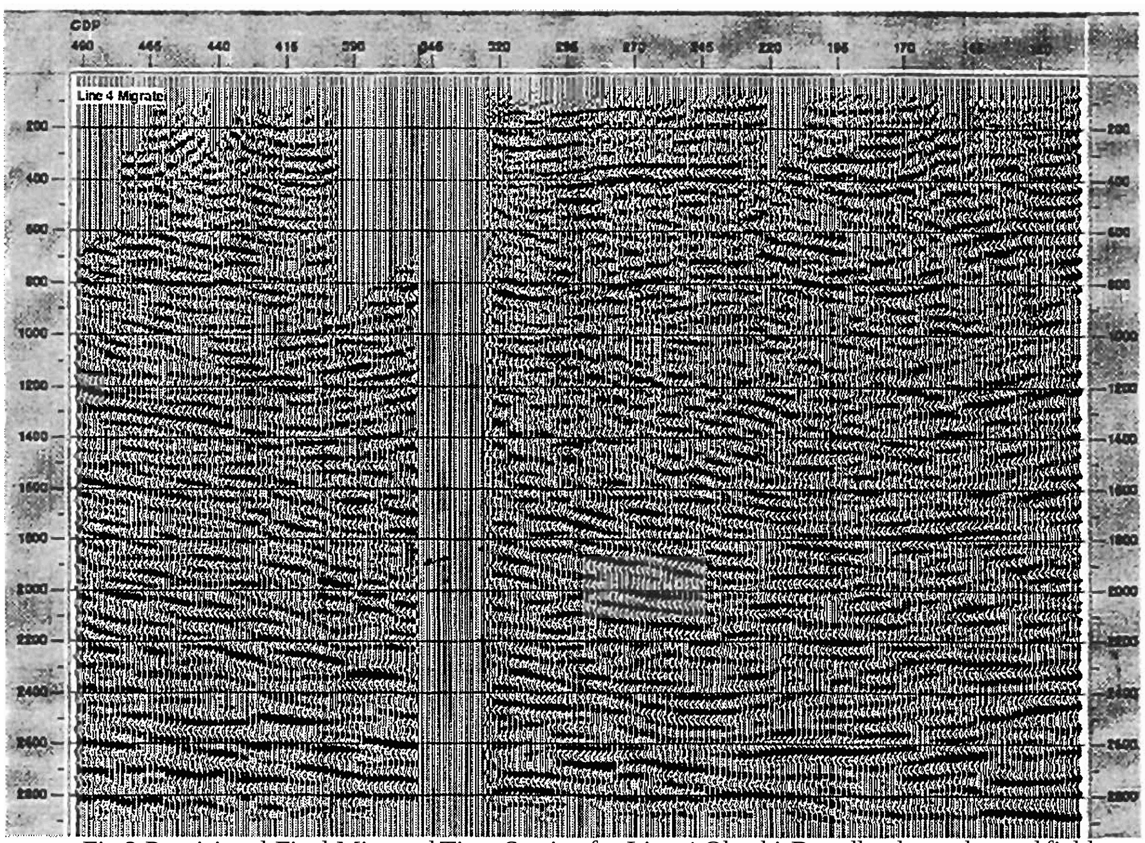

Fig **3** Provisional Final Migrated Time Section for Line 4 Ohaaki-Broadlands geothermal field.

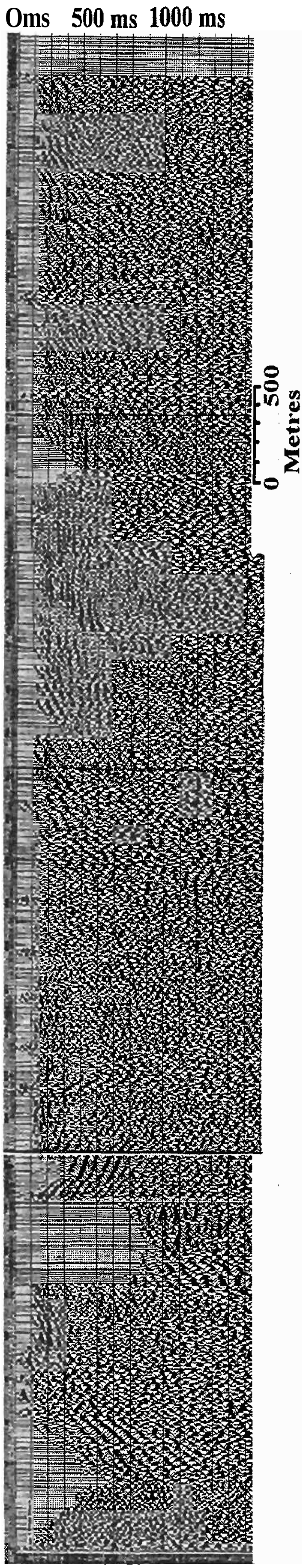

Fig 4 Initial Stack Line 1

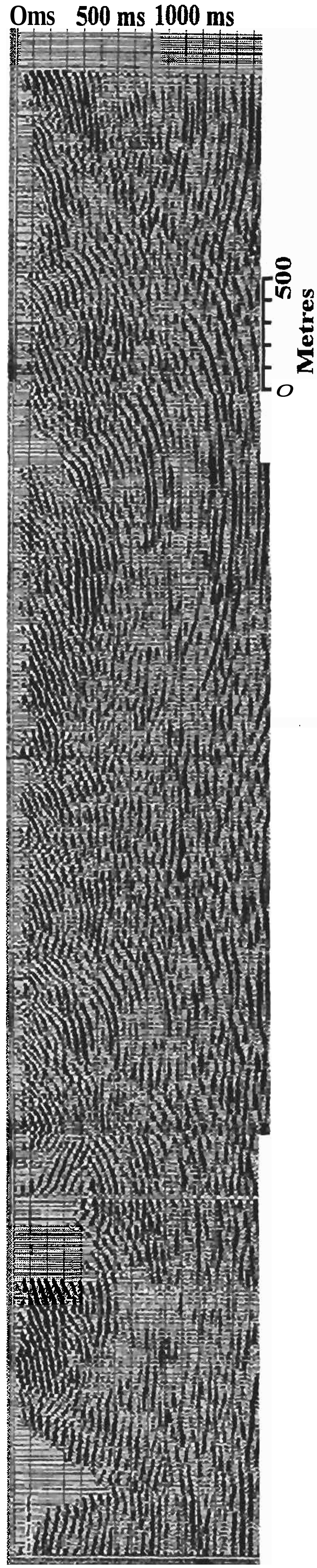

Fig 5 Final Migrated Time Section Line 1

The data was recorded by single geophone stations with an interval of 20m, and produced a 12 fold stack. The source was dynamite with shot holes drilled to a nominal depth of 10m (Henrys 1987). The final sections had very little indication of continuous reflections, and has been used to exemplify the difficulty of acquiring data in geothermal fields.

3. REPROCESSING

The reprocessed stacked section for Line 4, the northern most of the two lines that cross the Waikato River is shown in Fig 2. The migration corresponding to that stack is presented in Fig 3 and clearly shows an abundance of coherent strong continuous reflectors with a pinch out structure at the right hand side at approximately 400ms depth that should coincide with the Broadlands Dacite. The gap in the middle of the section is the Waikato River. The small section to the west of the river (the left hand side of the section), has indications of a similar pinchout, possibly associated with the Ohaaki Rhyolite.

Fig 4 is a raw stack of Line lwhich is the southern most line that crosses the river. This clearly shows the poor data quality along this line with the entire section being dominated by noise. The current final migrated time section is shown in Fig 4 and demonstrates a considerable improvement from the original stack. Again, this migration shows coherent continuous reflections that can be tied to well information. To the west it clearly shows a synclinal structure which differs considerable to most geological models of this area, it also shows a dominant deepening of the structure towards the west.

There are two areas with marked amplitude anomalies. The first is shown in Fig *6* at the western end of the section and very near the surface. This corresponds with the surface expression of the geothermal field, and could be caused by the presence of water vapour. Towards the eastern end of the line outside the presently accepted resistivity boundary to the geothermal field is another bright spot shown in Fig *6*. The high amplitude area is at an approximate depth of 300m, and appears to be capped by an unconformity above and to the west, and truncated to the east by a fault. This anomaly could indicate a geothermal vent that is trapped.

4. CONCLUSION

Techniques for seismic acquisition and processing are continually developing. This reprocessing has shown that with this development understandable seismic sections can be produced from even the poorest quality data.

The seismic data obtained from Ohaaki-Broadlands was reprocessed to show that strong continuous reflectors can be recorded in geothermal fields. The bright spots detected and their relevance to geothermal investigation were unexpected, this result does show that significant information can be obtained from seismic reflection in a geothermal environment.

With the availability of this type of data to supplement that currently used the development of geothermal fields can become much more a managed process, rather than the current hit or miss situation.

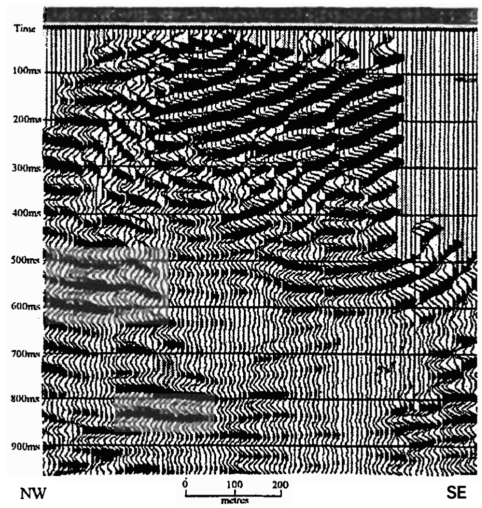

Fig *6* Amplitude anomaly beneath surface expression of geothermal activity, Line 1.

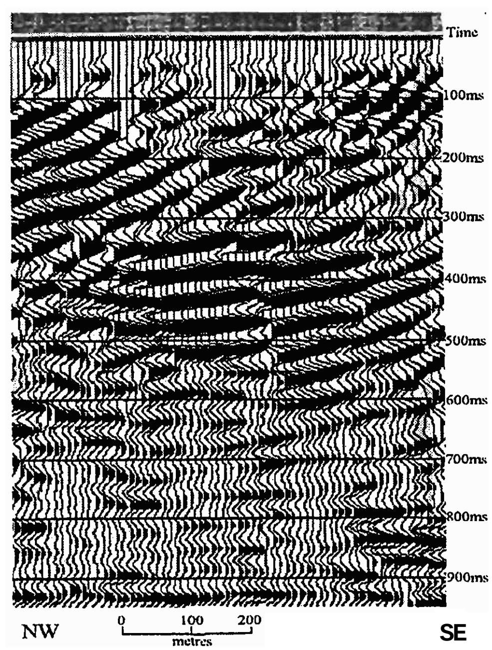

Fig 7 Amplitude anomaly at eastern end of Line 1. Anomaly is at approximately 300m, and is capped by an unconformity above and to the west and by a fault to the east.

5 REFERENCES

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