In-seam GPR and 2-C seismic investigations at the Goderich, Ontario salt mine

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ABSTRACT

In-seam GPR and 2-C seismic techniques used in conjunction with one another have proven to be effective as an exploration tool. This paper documents the field methodology and preliminary results of such an investigation at the Sifto Canada Inc. salt mine in Goderich, Ontario.

INTRODUCTION

In-seam ground penetrating radar (GPR) and two-component (2-C) seismic reflection techniques developed by IMC Geophysics Ltd. have been investigated at the Winsford salt mine in the United Kingdom for the purpose of exploration. The results of these studies have confirmed that rock salt is an effective medium for the propagation of seismic and radar waves. Seismic reflection provides the deep seam information, while the GPR provides the shorter range information which would fall within the seismic blind zone, making the two techniques highly complementary.

In August 1996, staff of Associated Mining Consultants Ltd. (Calgary) and IMC Geophysics Ltd. (UK) applied these techniques during a one week study at the Sifto Canada Inc. salt mine in Goderich, Ontario. The objectives of the investigation were to determine the effectiveness of GPR and seismic reflection at this locality, and to locate any disturbances in the salt beds which were suspected to lie beyond the workings. A schematic plan view of the survey area is illustrated in Figure 1.

GROUND PENETRATING RADAR (GPR)

The GPR reflection and transmission surveys were conducted using the Sensors & Software pulseEKKO IV™ system with 50MHz antennae. The antennae were held at a fixed separation of 6ft, with data being collected in reflection mode at 1ft station intervals. Test lines favoured an orientation such that the transmitter and receiver were held vertically, rather than horizontally, against the face of the heading. The transmission survey across a salt pillar of known width resulted in an average radar wave velocity of 0.12m/ns. This velocity was confirmed during a common-midpoint survey, and is in agreement with velocities from the Winsford salt mine.

Figure 2 is a typical example of the raw GPR data obtained at the Sifto mine. The data for this section were collected at heading 66A of Survey 2. Horizons from above and below the headings, as well as from adjacent headings are observed in the profile. This is a result of the fact that the radar energy is transmitted in all directions, and not just ahead of the faces. Taking these reflections into account, the ground appears to be free of obvious discontinuities within the range of penetration.

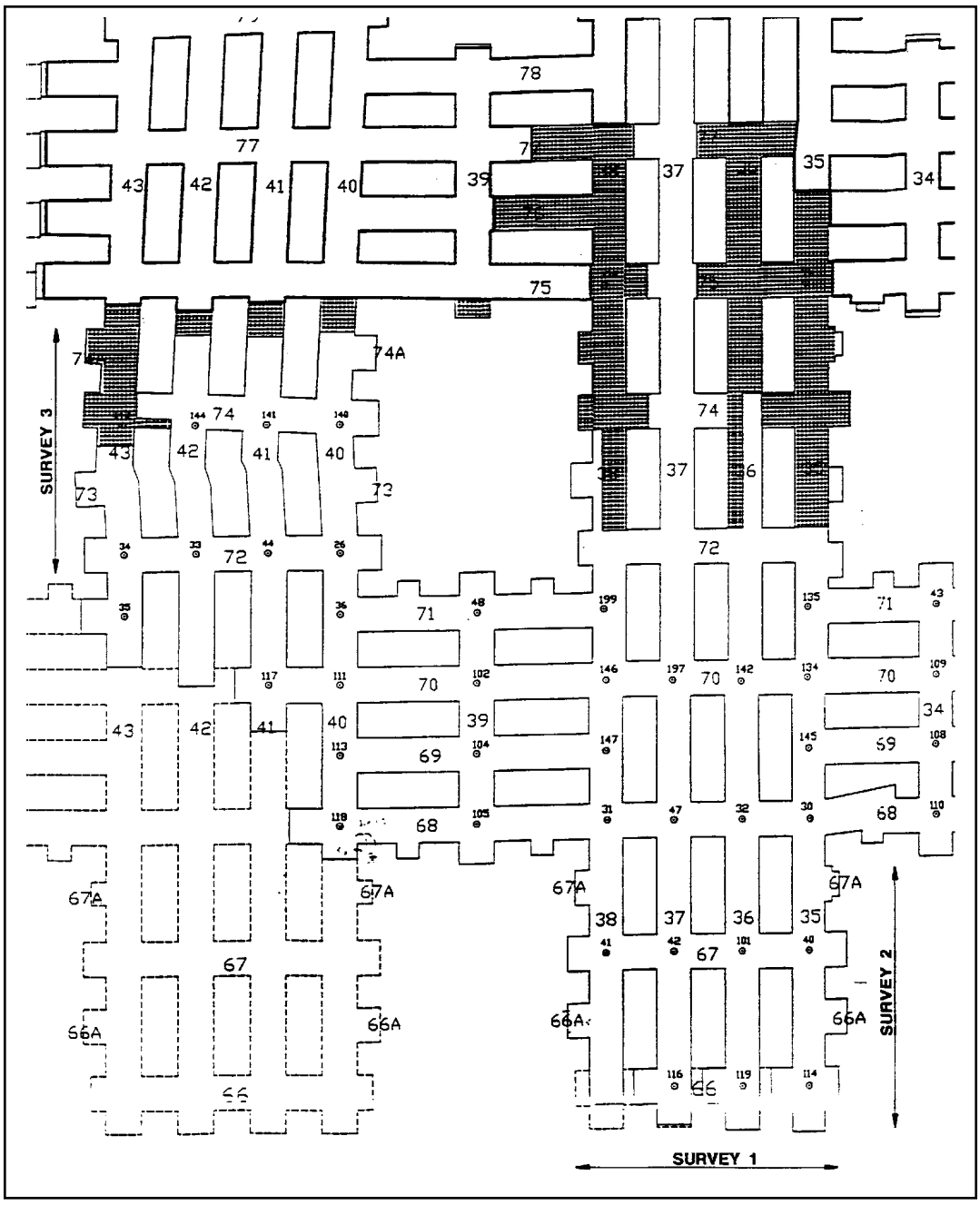

Figure 1: Schematic of survey locations

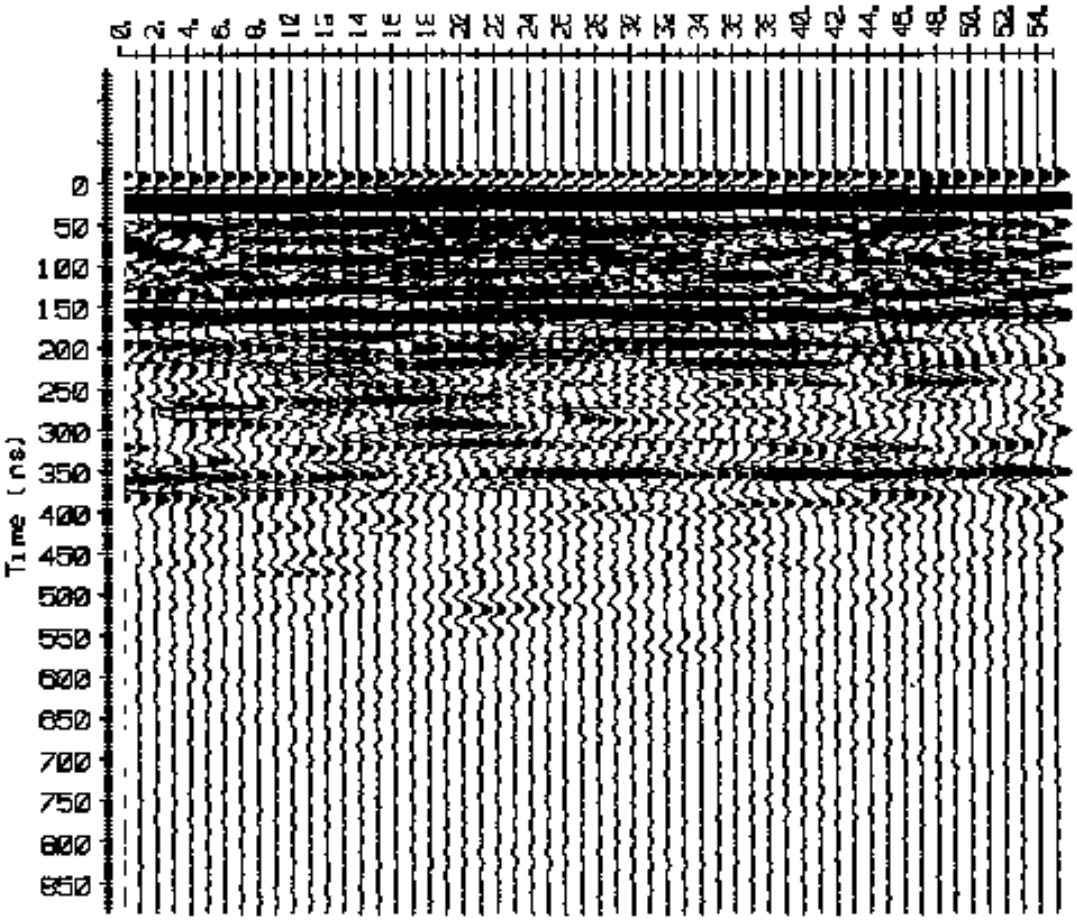

Figure 2: Raw G.P.R. section, survey 2, heading 66a

TWO-COMPONENT SEISMIC REFLECTION

The data from the transmission and reflection surveys were recorded using a Geometrics Smartseis, 24-channel digital seismograph with a 0.5ms sample rate. The seismic source was provided by ICI Powermax explosives in 6.5ft deep holes with clay stemming. The receivers were in the form of twelve geophones with two horizontal components (x and y). These were designed by John Gregson of IMC Geophysics, and were configured such that the odd-numbered channels comprised the x-component (parallel to the face of the heading), and the even-numbered channels comprised the y-component (perpendicular to the face of the heading). Figures 3 and 4 illustrate the shot and receiver configuration for the three reflection surveys.

P and S waves are clearly observable in the raw shot records, and the transmission survey indicates that their respective velocities are 3846m/s and 2381m/s. These velocities yield a Vp/Vs ratio of 1.61, and are similar to those determined at the Winsford salt mine.

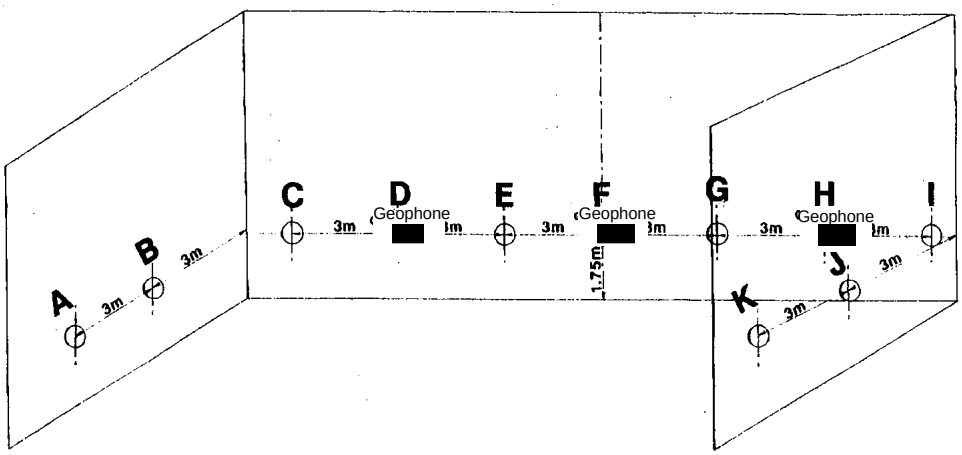

Figure 3: Shot (A-K) and receiver (▬) configuration

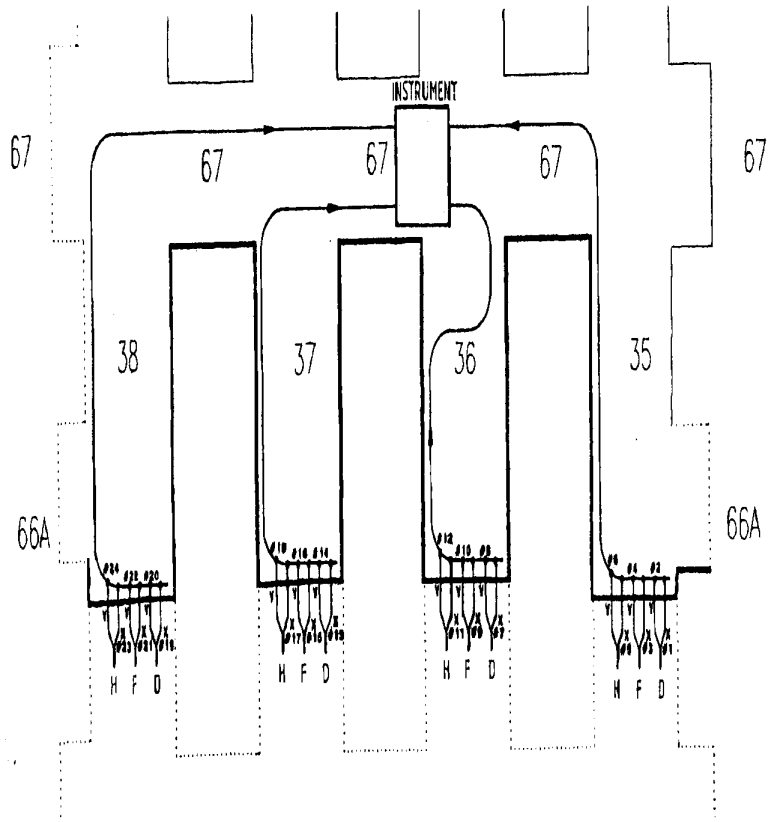

Figure 4: Schematic of survey layout. Note: three receivers per heading, each consisting of two horizontal components (x and y).

CONCLUSIONS

The results obtained from the current investigations at Sifto Canada Inc. Goderich salt mine, in addition to those of investigations at the UK Winsford mine suggest that in-seam seismic reflection and GPR used in conjunction with one another constitute an effective exploration tool.

ACKNOWLEDGMENTS

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