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ELECTROMAGNETIC WAVE PROBING FOR SALT DISCONTINUITIES

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by

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CHAPTER I

INTRODUCTION

At the June 1971, SMRI Meeting in Denver, some questions arose as to the usefulness of the radar probing method in bedded salt occurring in the Michigan basin or upper New York State. Hitherto, our research has been carried out only in the dome salt of the Grand Saline salt mine because we wished to keep the research costs down by experimenting in a nearby mine. Therefore, we could not answer the question from experience. To find out, we accepted the kind offers to experiment in the Goderich and Cleveland mines of Sifto Salt and International Salt respectively, and arranged a week of research in both mines, visiting Cleveland first. A last minute hitch arose when we found that state and federal regulations permitted no gasoline in either mine. (All our electronic equipment is powered by a gasoline-driven electric generator). After some fast foot-work by the management of both mines* a variance was obtained from the respective Bureaus of Mines to allow one gallon of gas into the mine. This was sufficient for our electric generator (a 4 hp. Briggs and Stratton gasoline engine powers our generator). The total two weeks of research went off without any problem caused by gasoline.

Other problems we expected to arise, did arise. The bedded salt contains more impurities and more moisture which was therefore expected to present more attenuation to our electromagnetic waves. This became apparent immediately in the Cleveland mine. Goderich followed suit.

*Our special thanks for this fine cooperation.

As a result we found that, whereas in the Grand Saline mine we could easily see through 400 feet of salt to the top of the dome with our Charlie IA radar, in neither northern mine did we ever see targets this far. In fact with the Charlie IA radar, we were able to detect reliably, targets in the range from (our radar minimum) 160 feet to 250 feet. Another way of stating this is that the bedded salt is more lossy to electromagnetic waves than dome salt.

What does this mean as far as the use of radar in bedded salt is concerned? This simply means that in bedded salt we have to try harder. We try harder by using equipment more powerful than our Charlie IA radar, namely our Bravo I equipment (see Table IV page 25 of the Second Biannual Report, May 1970). This Bravo I has a peak power output of 10,000 watts as opposed to 3 watts for our Charlie IA. Also Bravo I operates at a lower frequency than our Charlie IA which should also increase its range of penetration of salt. The lower frequency and longer wavelength of Bravo I (21.2 inches in salt as compared to 11.05 inches for Charlie IA) allows us to look for bigger discontinuities without being so badly affected by bands of impurities.

Whereas the Charlie IA radar gave only marginal results in bedded salt, our ECHO I equipment gave suprisingly good results. As discussed in detail in a later chapter, at Goderich we were able to measure the distance through the floor to a known (and visible) salt-dolomite interface. We measured 12.6 feet with our ECHO I radar and the real salt-dolomite interface was measured as 12.6 feet. Our measuring accuracy is not really this good; we can expect $\pm$ 1 foot from ECHO I. The radar measurement was made alongside a deep cut in the salt floor for a conveyer belt, where the contact was exposed and measured.

The reader will recall that at Grand Saline with ECHO I (Third Biannual Report, p. 21 ff) we were able to profile the room beneath the salt floor, obtaining penetrations of the solid salt floor to ranges up to 34 feet. With the increased moisture and impurities in the Canadian salt causing a higher attenuation we were indeed pleased to get these results particularly when a salt-air interface gives a better reflection coefficient than a salt-dolomite interface (see Appendix B for a discussion of this).

So we have a new first. This is the first time anyone has measured the thickness of salt beneath a salt mine floor when the salt contacts another rock. Further, we obtained a value agreeing with the measured thickness. This was in the Goderich mine. In the Cleveland mine we obtained data with ECHO I on three possible interfaces. These data have not been confirmed because they were not taken near a cut in the floor.

selected is to be representative of the particular mine's "best," "average," and "poorest" salt, with these catagories being mine personnel estimates of the presence of impurities. By "best" we mean the most pure, the other two catagories being increasing amounts of impurities. The objective of the laboratory investigation of these materials will be to determine the electrical properties of the salt as a function of both the particular mine which produced it and the quantity of impurities present. Since we now have CHARLIE IA radar data from three different mines, an additional objective will be to determine if a correlation can be established between the laboratory data on the loss tangent of the mine salt with different degrees of impurities and the CHARLIE IA radar range data obtained from inside each mine. It is expected that in the future, such a correlation can be established and from this the radar power and frequency required for a particular desired range can be determined.

D. Summary

By obtaining shaped salt samples to fit our GR 874-LM Dielectric Measuring Line, we are able to employ the most accurate and sensitive laboratory equipment to measure the electrical properties of salt. These data, used with our newly acquired CHARLIE IA radar data from Cleveland and Goderich mines along with that from Grand Saline, will enable us to establish a correlation between laboratory data and radar salt mine data.