The MinEx Associates Group

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'Sound and Innovative Mineral Exploitation and Exploration'

RAP Geophysics (RESONANCE ACOUSTIC PROFILING) HARD ROCK APPLICATIONS

Since 1995 MinEx and its Associates had used the RAP geophysics method on hard rock ground surveying especially with primary diamonds. Up until 2010, the focus has been on alluvial situations. In 2010 MinEx were commissioned by a senior mining company client to undertake a study to interpret an area within the Kalahari manganese fields.

The results proved readable and several industry experts were impressed. They speculated that RAP could be suitable for:

1) Pre-planning drill programs to better select hole collar positions.
2) Significantly reducing the size of drill programs by reducing grid spacing.

The results of the Kalahari study show that RAP captured detail of geological structure, strata, tectonic and fracture/fault features of the on the lines/sections run. Various parameters were applied and features were not only identified to 400m as predicted, but features at deeper levels down to 750m.

Assuming a current minimum cost of $25-30 000 per physical drill hole, RAP geophysics is a very real and economical option and alternative to supplement and vastly reduce the cost of the exploration program. RAP can logically define physical hole planning of the total property area and vastly reduces infill drilling.

With expert acreditisation, the technique could eventually be assessed as a valid method of defining resources to SAMREC standards. As the company wants to increase its resource footprint as a priority, RAP can be used to prioritise targets for drilling to where the manganese ore body appears more viable, rather than drilling at random.

As more RAP is performed and it becomes transparent that the results can be proved by drilling, a better understanding of applicable variable parameters and interpretation techniques will be gained for a specific property. This in turn leads to more accurate, faster results being produced. The results can be simplified to lend themselves to 3D modelling.

The graphics and interpretation produced in the Kalahari work correlated well with known drill data. This provided a starting point and beyond doubt shows that RAP is the best (if not the only) known geophysics technique applicable to Northern Cape's manganese geology.

Further work on the large amount of data collected will define far more detail by application of various mathematical parameters and processing analyses, producing more graphics and clearer more detailed interpretation. Once the two dimensional interpretations are optimised, the interpretations can be combined to give a three dimensional models. Additional analysis of data collected away from site will give more accurate and useful detail. That information more accurately (and very much more cheaply) define reserves and be the basis for eventual mining strategy.

GEOPHYSICS METHOD DESCRIPTION

The method has been used successfully on alluvials to 50m with good accuracy and on hard rock ore bodies to 500m. The diagrams to follow are examples of graphic sections produced on hard rock ore bodies.

The technique is based on new approaches to the interpretation of acoustic signals and research carried out in the former USSR and other countries. Compared to traditional seismic methods, RAP explores ground resonance responses to external shocks within a much wider frequency range.

RAP has been in use over the past fifteen years or so and has been developed, refined and proven applicable to a wide range of industrial applications. Results graphically show interface boundaries between different materials and structures as well as shear zones, intrusive igneous masses and sedimentary layering.

RAP surveys are carried out along profiles with 1 to 20 m spacing between measuring stations depending on client's requirements and local geology. Field 'calibration' is based on available known geological and other data. Once this 'calibration' has been done, RAP images can easily and accurately be extrapolated. Line simplifications can be interpreted and superimposed that can be applied to computerized 3D modeling.

RAP profiles are presented as raster images compiled by the correlation of processed discreet records into continuous cross-sections. The cross-sections show variations in acoustic resonance properties (not simply reflected properties as with conventional techniques) and may be calibrated for real depths and interpreted in geological, hydrogeological and/or geotechnical terms based on available drilling data, pitting or other information. Once signatures and features have been physically defined and are understood, RAP profiles can be applied to infill, extrapolate and predict other features with confidence.

Certain processing and interpretation algorithms have been developed for some 'standard' geological situations and target features – e.g. for diatreme structures and strata features at different depths. Such algorithms make it possible to successfully use RAP in grass-roots exploration with very limited geological information.

The advantages of the technique are as follows:

Very portable field equipment (standard 6 kg including 12V batteries) makes it possible to use RAP in remote areas without expensive ground clearing and gridding. Some standard portable GPS/DGPS equipment may be used for profile and station positioning, development of palm top equipment (instead of mini laptop) will reduce this further. This may seem insignificant, but with other seismic methods it can be a huge problem to clear bush properly, to transport equipment and to cross international borders with it. All the equipment required for RAP can be fitted into a suitcase. Cables, batteries etc. can be purchased in all but the most backward countries.

A 2-person field team makes it possible to make a few hundred measurements per day (depending on station spacing and ground conditions).

RAP may be used in areas where conventional EM techniques and Ground Penetrating Radar fail to provide reliable results due to soil salinity and unfavorable hydro-geological conditions. Good interference resistance makes it possible to use RAP in urban environments or on mine-sites.

Interpretable results are from primary data processing. Annotated, presentable, graphic results are therefore available for inspection just a few hours after gathering data. If many lines are run, the data processing will lag the data collection but this allows for checking of interesting features by returning to them.

Prices depend on the station spacing and ground conditions, and include field work and interpretation/reporting.

The RAP depth range so far practiced is from less than 1 m to approximately 500 m, though incidental clear features have been identified to 700m during the course of practice.

Different frequencies are used for different depths. The resolution depends on surface conditions and geology, and may be adjusted for different depths using available acoustic sensors and various recording time/frequencies. The technique has already been successfully used in primary and alluvial diamond exploration in Russia, Ukraine, Africa and Australia (pipes and dykes & alluvials) as well as on a number of environmental, geotechnical and hydrogeological projects.

RAP has been applied to coal very successfully but these results unfortunately cannot be published because of client confidentiality. Coal is one of the highest potential future applications of RAP because of vast electro-mechanical properties between coal, shale and intrusive features. Coal fields because they are large sedimentary features cover large areas where extensive drilling would be required to understand variations in the geology.

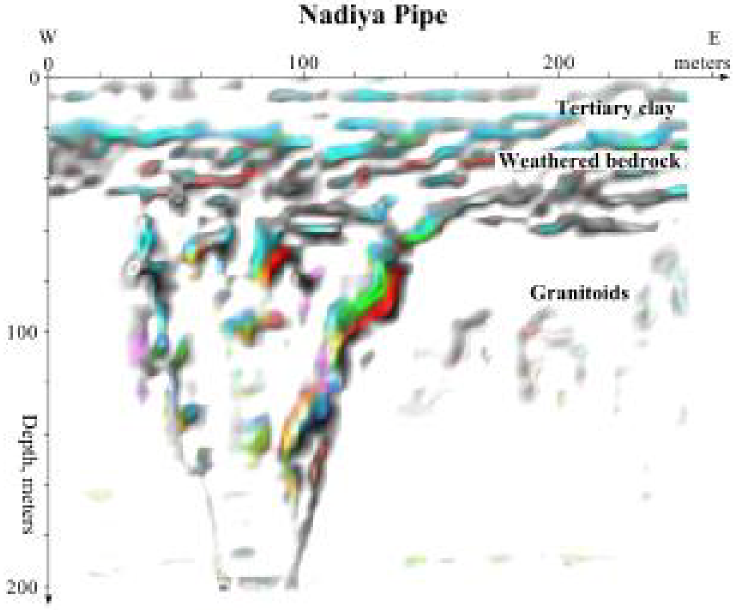
RAP may be used as a cost-effective alternative/support to traditional geophysical techniques and core drilling in mining and exploration projects. It is effective in particular for the delineation of discovered geological bodies and search for their extensions, in testing magnetic/EM anomalies. There also are obvious and proven RAP applications in regolith research, applied civil engineering, geotechnical and environmental projects.

The following are examples of graphic profile representations:

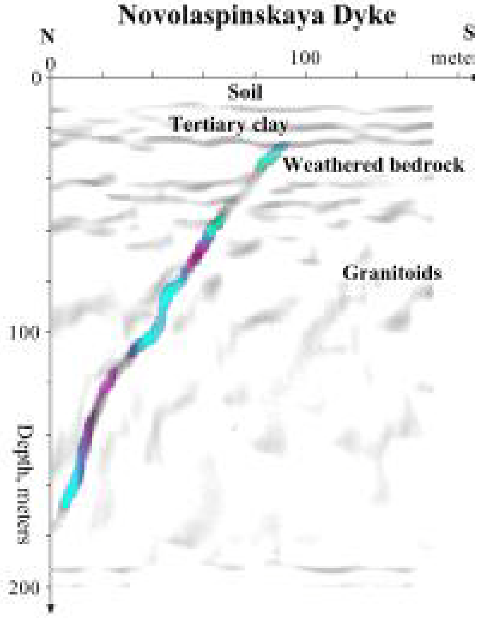
UKRAINIAN KIMBERLITES - 1998

(Priazov Shield)

Nadiya Pipe

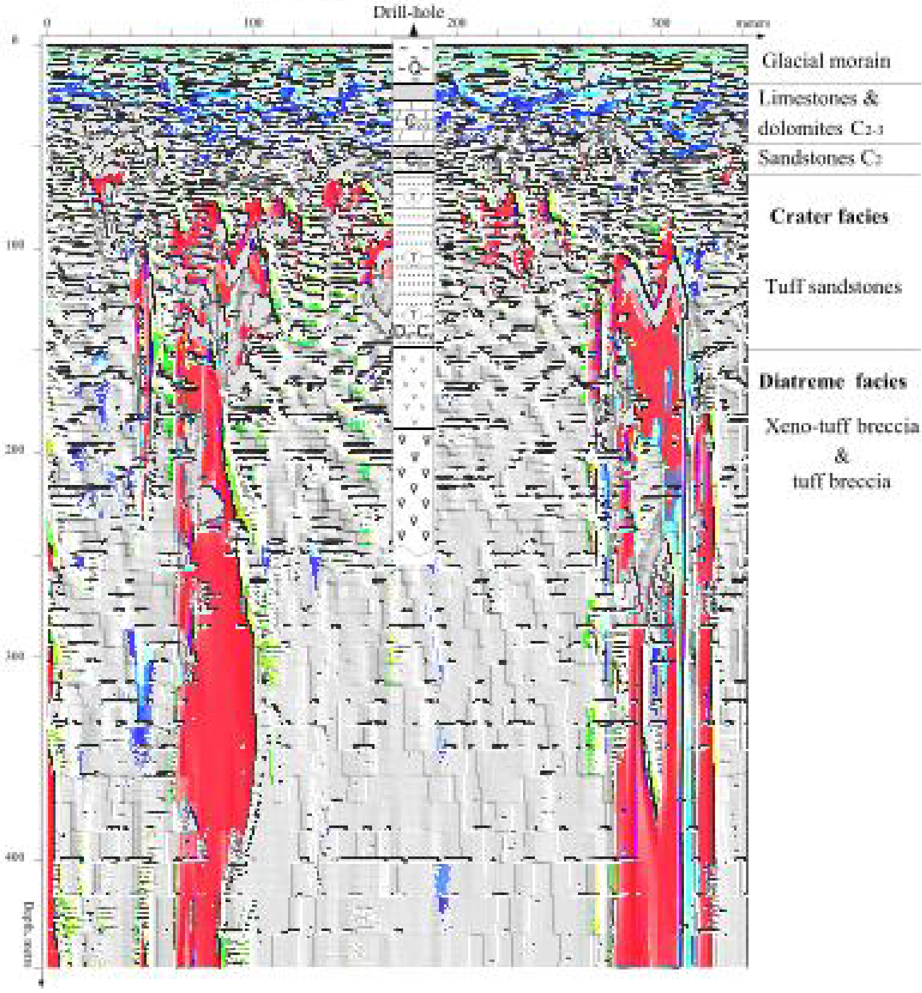


Novolaspinskaya Dyke



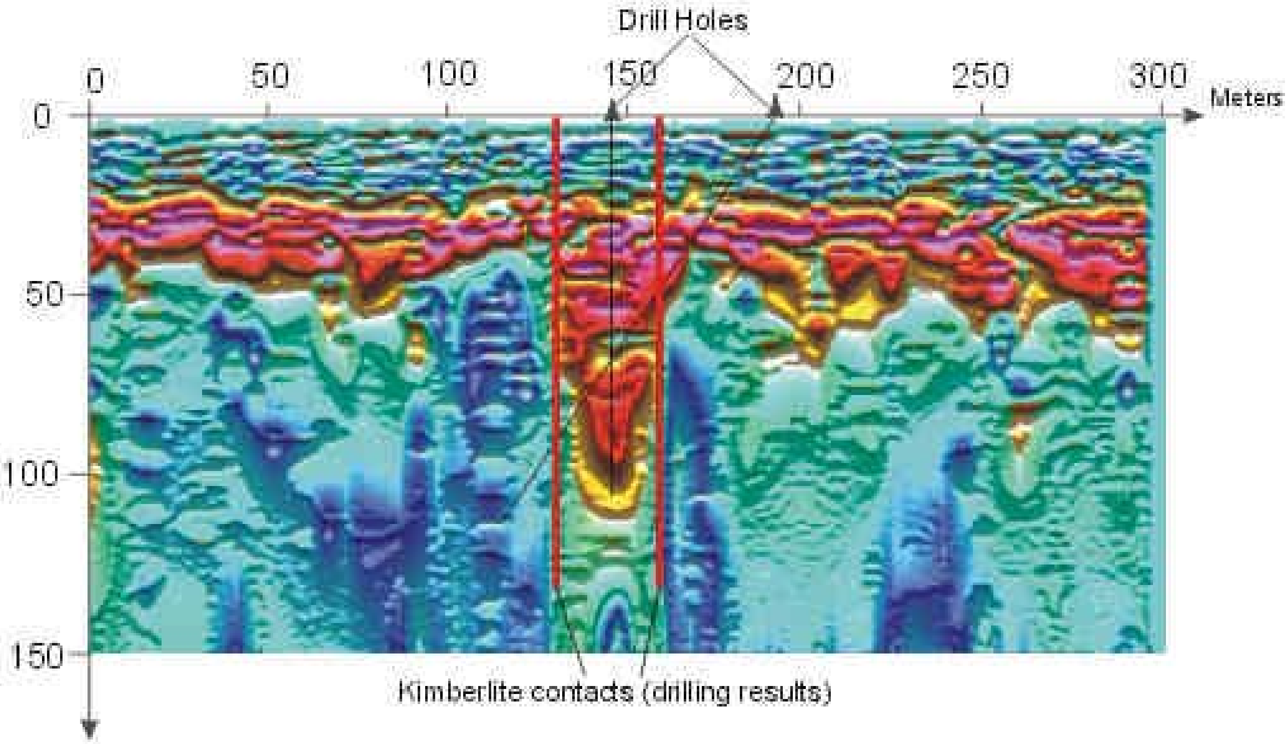
ARCHANGELSK DIAMOND PROVINCE (NW Russia)

Known Pipe

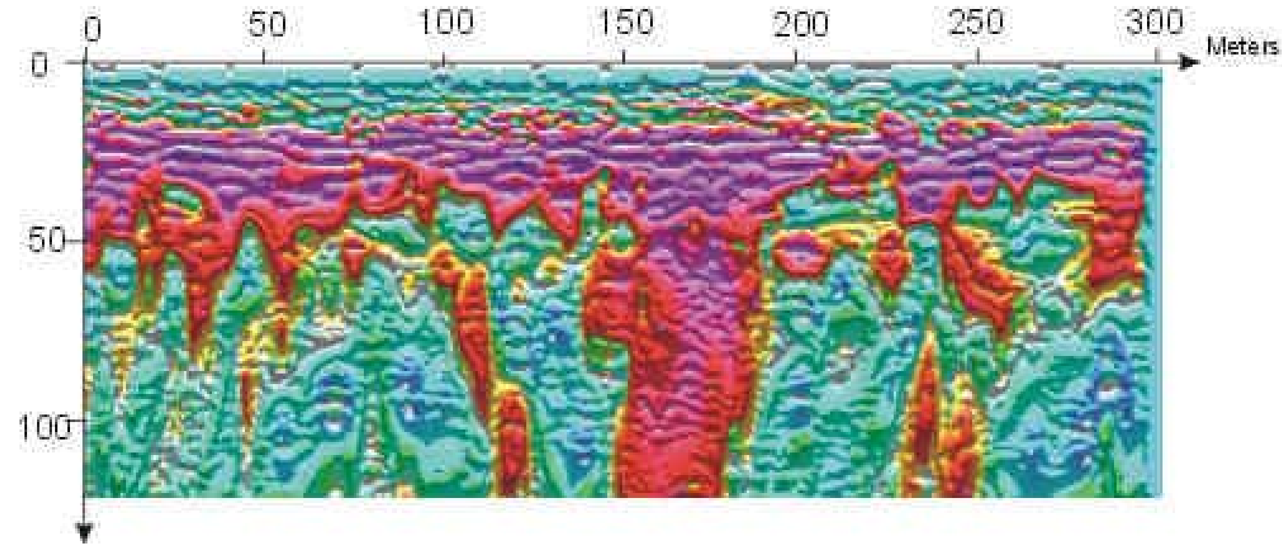


SOUTH AFRICAN KIMBERLITES

KNOWN PIPE (NORTHERN PART OF **R.S.A.**)



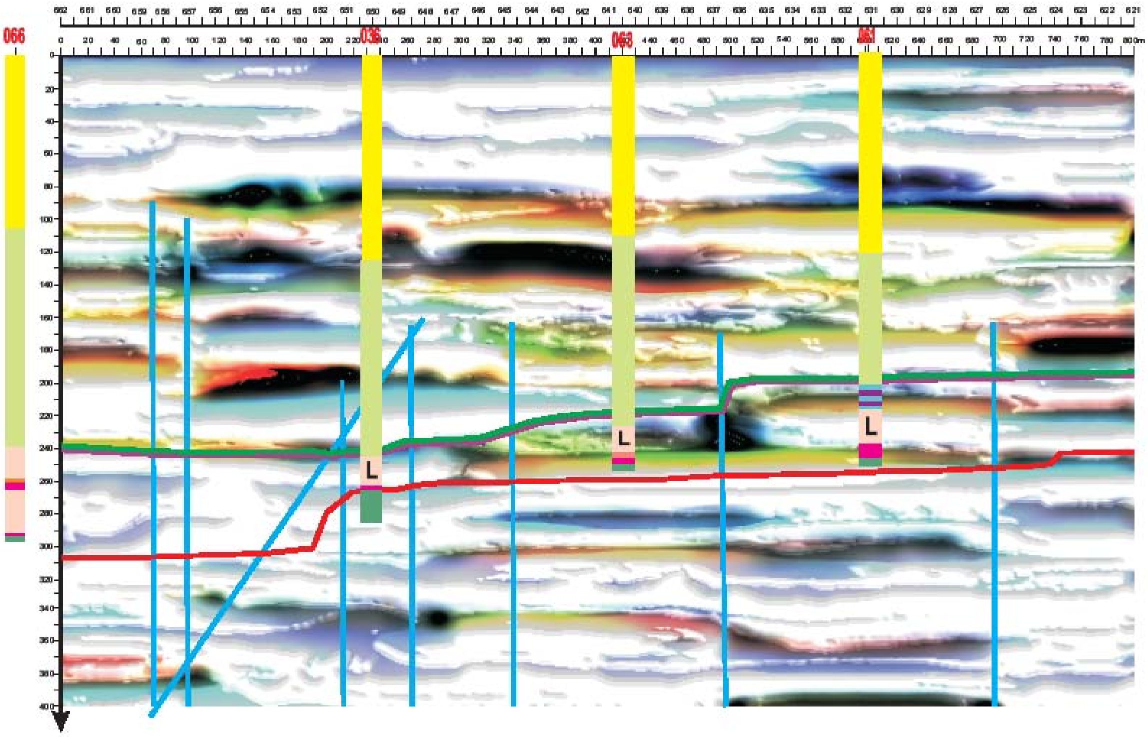
KNOWN PIPE (KIMBERLEY AREA)



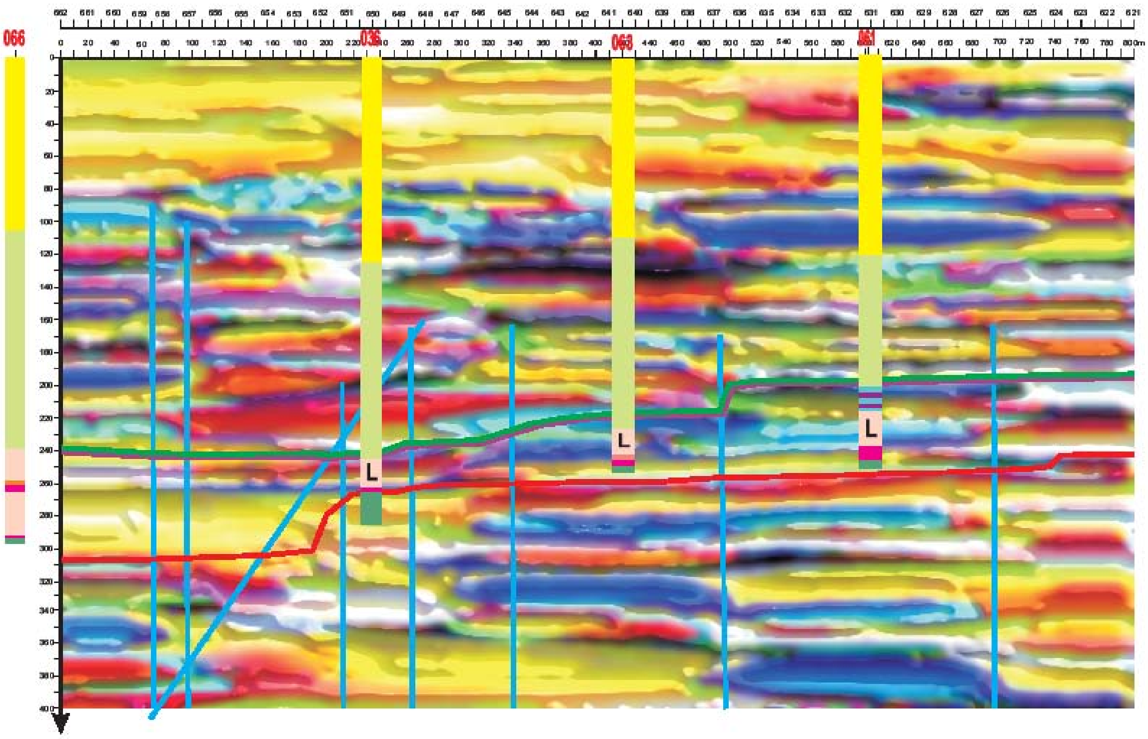
The following are profiles from the Kalahari Manganese fields in South Africa.

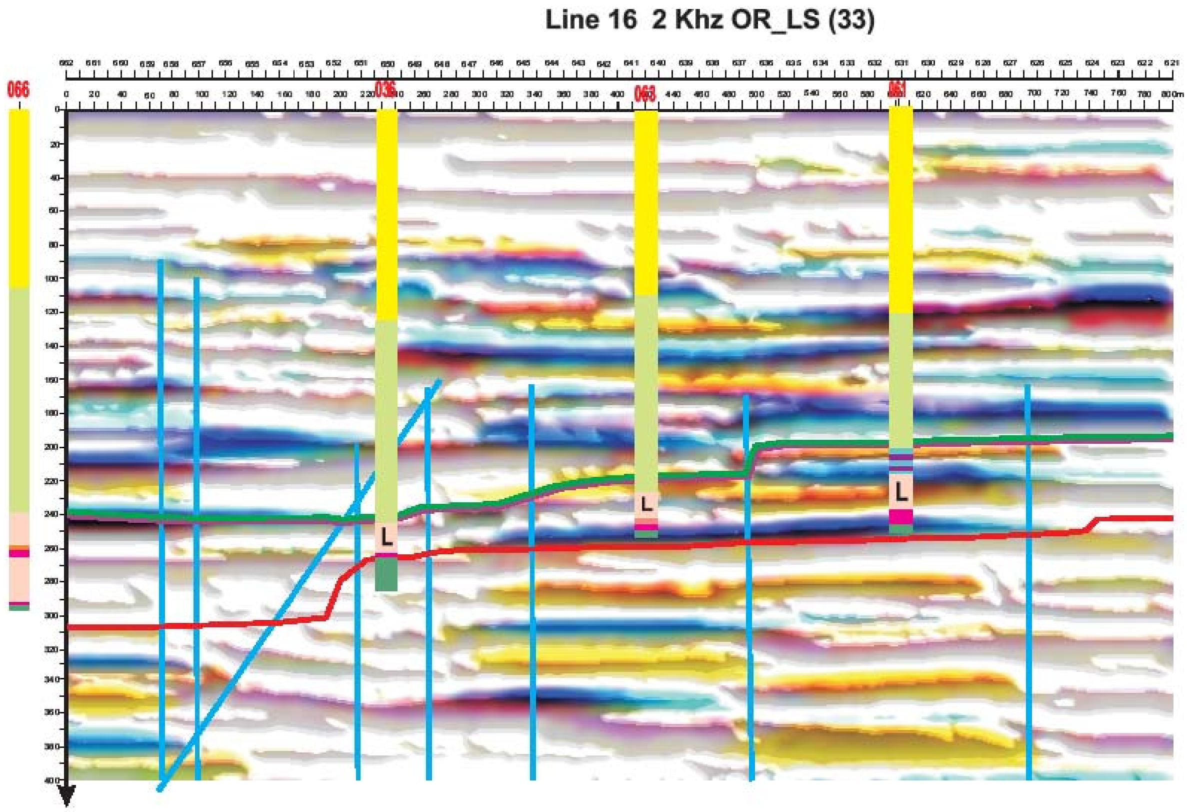
The information is limited due to client confidentiality. Diagrams show annotated images and simplified line interpretations superimposed onto drill core logs. Several images have to be superimposed to create an accurate reflection of the entire depth sequence.

Line 16 2 Khz



Line 16 2 Khz OR_LS (32)





DESCRIPTION OF FIELD GEOPHYSICAL EQUIPMENT AND METHOD

RAP equipment consists of a hammer and peg to create percussion. Various pegs and hammers are initially used to produce a consistent reading within certain frequency and volume limits on the specific surface material being surveyed. In the below photograph, three different experimental pegs can be seen. The optimal signal was produced with a mild steel flanged bolt, the flange ($50mm^2$) prevented the bolt penetrating into the sandy material and produced a good signal with very modest percussion energy.

There is a geophone, seen in the middle of the picture below, figure 1, this is not a normal seismic geophone used in conventional seismic survey, it uses supersensitive electro-acoustic materials and records over a wide frequency range. This has been developed over more than fifteen years and used cutting edge technology and materials originally obtained from military sources in Russia. Nowadays these materials are obtained from the USA and Europe where they have been further developed as compared to the original materials used fifteen years ago. In some situations the original material is still the best option.

The geophone feeds to electronic circuitry box which has several functions but primarily changes the analogue signal into a digital output which is fed into a field computer which is then recorded. The computer records wide range digital frequency response to the percussion and enables different recording time periods depending on frequencies being sought. Experimentation on eight frequency regimes during the first two days of field trials enabled a decision to be made that that two frequencies would be measured during the entire trial work, 2 and 4 KHz, both in a 'compressed regime'. Normally only one frequency is used during a survey. In this case of deep data collection, data collection at two frequencies allowed additional information to be collected, though reduced the normal speed of survey.

The above photograph, figure 1, shows the percussion, geophone, ‘electronic box’ and mini field computer

Percussion is repeated at intervals along lines where sections are required and analogue recordings of the responses are digitised and accumulated.

After the day’s field work, the data collected is fed from the mini field computer into a standard laptop computer which is able to convert the information into line raster images ready to be interpreted.

Drill results should be supplied (if available) for superimposition onto the RAP images.

Personnel

Geophysics is only as good as the team of individuals using the equipment to collect data, process and interpret results.

MinEx have years of experience in setting up and executing these projects in various difficult countries and understand the logistics, requirements and equipment well. The following people are involved with a geophysics projects.

Steve Canby, B.Sc. (Hons.) NADSAM MinEx
Minerals Exploitation Engineer, gold, tantalite and diamond exploration, alluvial, primary & production and processing specialist

Steve, graduate of Cardiff faculty of Minerals Exploitation, brings 30 years of mining related project experience. He started his career at Anglo American and De Beers and has worked for many companies since. Over the past ten years he has set up and guided MinEx Associates who are active now in Swaziland, Mozambique and the UK.

In diamonds specifically, he has worked for the Trans Hex Company, Archangel Diamond Corporation, Lion Mining, Rex Mining, President Mining, AMCAN Mining and Oryx Natural Resources, SLDC and Target Resources. In gold projects specifically, he has worked for Central Asian Goldfields, Glamis, Ecuador Minerals, Kampe Valley (Nigeria). He is a loss control, risk management and safety expert (NADSAM). Between 2006 and 2007 he set up Wardrop engineering in the UK.

He is experienced in primary and alluvial diamond exploration management, dredging, jig and pan plant and conventional DMS plant design and operations. He specialises in overall project productivity enhancement and production output increase. Steve has designed and bought process plant in all parts of the world, usually erecting, commissioning and operating them.

Steve is multilingual and has been immersed in French, Russian, Spanish, Portuguese and Zulu environments over the years. Much of the past fifteen years has been involved with exploration and evaluation projects, involving lease selection and acquisition, operational set- up, purchasing, administration commissioning of earth moving and process plant.

Steve will oversee the entire technical and organisational requirements of a MinEx geophysics project and emplace personnel required.

Valery Lazebnik
Exploration and Geophysics Expert, Geologist, diamond specialist

Valery is a graduate of the Dnepropetrovsk Mining Academy, a specialist in diamond geology and a highly practical geophysicist, with over 30 years experience in exploration and assessment, worldwide. He pinpointed channels and depression features for Target and worked for SLDC (now African Minerals LSX-AIM) with MinEx and Wardrop Engineering). He was Principal Geophysicist on several Russian Expedition teams and worked for Alrosa for 14 years, ending up as their Chief Geophysicist.

Valery's work lead to the discovery of more than thirty diamond pipes and dykes in Russia and Africa, most notably the Grib Pipe in Northern Russia where he was the individual who originally identified the drill target from air magnetic images, did on the ground RAP work. The Grib is now a world class deposit.

Valery has a team available in St Petersburg who specialise in air-magnetic data interpretation and ground geophysics work and is a co-inventor of the RAP technology.