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Sound and Innovative Mineral Exploitation
Geophysics Options - Alluvials

Why Use Geophysics for Alluvial Exploration?

The major expense in alluvial mining is excavation or dredging unproductive locations in an attempt to 'hit hotspots'. Alluvial deposition is never homogenous. Valuable heavy mineral is always irregularly deposited depending on river shape dictated by the geology underlying the river or ancient river (palaeochannels).

In concise summary, heavy mineral deposition points (features) are:

1) Depressions in the bedrock, longitudinally or laterally
2) Rock-bars including waterfall features
3) Alluvial confluences
4) Pools or eddy current potholes
5) Bends
6) Gradient changes (high to low)

These may be active or palaeo-features. Other places on a river system are not going to concentrate any heavy minerals and should not be worked.

The difficulty is in identifying the above features, and equally importantly, their absence. Of thousands of rivers and streams in the world that produce heavy minerals, only a fraction of a percent have ever been productive on a commercial scale. Many serious alluvial projects would not have failed concentration points could have been identified before earthmoving or dredging had commenced.

It is one thing to sit in an office with maps and satellite images, but when a river or palaeo-system is physically observed, the challenge becomes real. Monstrous quantities of sands and gravels have to be moved. Equipment and running costs are incredibly expensive.

Alluvial mining has been, up until now, a very 'hit and miss' affair based on local knowledge, maps, satellite images and auger sampling followed by trial pitting or trenching. Often the above mentioned features of deposition are not seen at all until expensive river diversions or open cast pits are made, exposing them. Even then, they are difficult to identify and understand because rivers are continually changing and hide geological and topographical features. Invariably huge volumes of material must be moved before any clue of actual depositional features is known. Working in river sands and gravels is very expensive, messy and difficult.

Success stories on alluvials have been almost entirely due to selecting obvious features (most of which have been mined out over the last century) or by sheer luck. Most features are not obvious and have long ago been covered by river sands, soils or even deeper sediments.

These features change rapidly in terms of alluvial history. Within ten years some features are lost or buried and cannot be observed. Within a thousand years alluvial sands can completely cover and disguise the above listed features. Most major to medium sized river systems are tens of thousands, if not hundreds of thousands of years old. Significant features may be deep on mature river systems. Without geophysics there is no hope to identify them.

In the case of 'active' or flowing rivers, trial suction dredging is the only method of exploration. There has until recently been no method to inspect sediments, or bedrock profile patterns underlying water, river sands and gravels. It makes no sense to dredge an entire river with a large commercial cutter head dredge, but if the deposition points are located, it makes perfect sense to attack those and clean them out comprehensively.

Conventional exploration methods are expensive, very localized and time consuming and can only reveal relatively shallow features (usually not deeper than ten to fifteen meters on dry land, five meters on an active river).

It is very difficult to raise funds for alluvial projects, simply because very little can be proved or inferred by conventional exploration and assessment methods.

Cutting edge geophysics methods have completely changed this situation over the past five to ten years. The above listed depositional features can be relatively cheaply and very quickly identified. This allows for non productive areas to be ruled out for any mining development and productive features to be identified and concentrated upon for pitting and dredging. Typically, geophysics methods will clearly show that 99% of a river system will be very unlikely to be commercially viable.

What methods are used and proven?

There are two methods MinEx have tried and tested worldwide but particularly in West Africa. To our knowledge there are no other companies able to offer geophysics leading to clear readable results.

1) **RAP (Resonance Acoustic Profiling)** – a dry method, used OUTSIDE of water. Very successful results with RAP were initially produced 1992. This is a proprietary technique not commercially available until now and only through MinEx, Major technical advancements have been made since the 1990's.

2) **SBP (Sub Bottom Profiling)** – a wet method used INSIDE the river water. MinEx acquires a SBP machine in 2008. By combining RAP data processing software, extremely readable material has been produced.

Resonance Acoustic Profiling (RAP)

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 wide 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 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.

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 reflected properties as with conventional techniques***) and may be accurately 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, RAP profiles can be applied to infill, extrapolate and predict other features with complete confidence.

In the case of alluvial deposition features, depressions, rock-bars, pools and palaeochannels are clearly seen without physical confirmation. Drilling etc. will of course confirm actual depths and materials causing boundary differences.

Even for hard rock geology, certain processing and interpretation algorithms have been developed for 'standard' geological situations and target features – e.g. for diatreme and sedimentary structures. 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.

- A single person or 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 hydrogeological conditions. Good interference resistance makes it possible to use RAP in non rural environments.

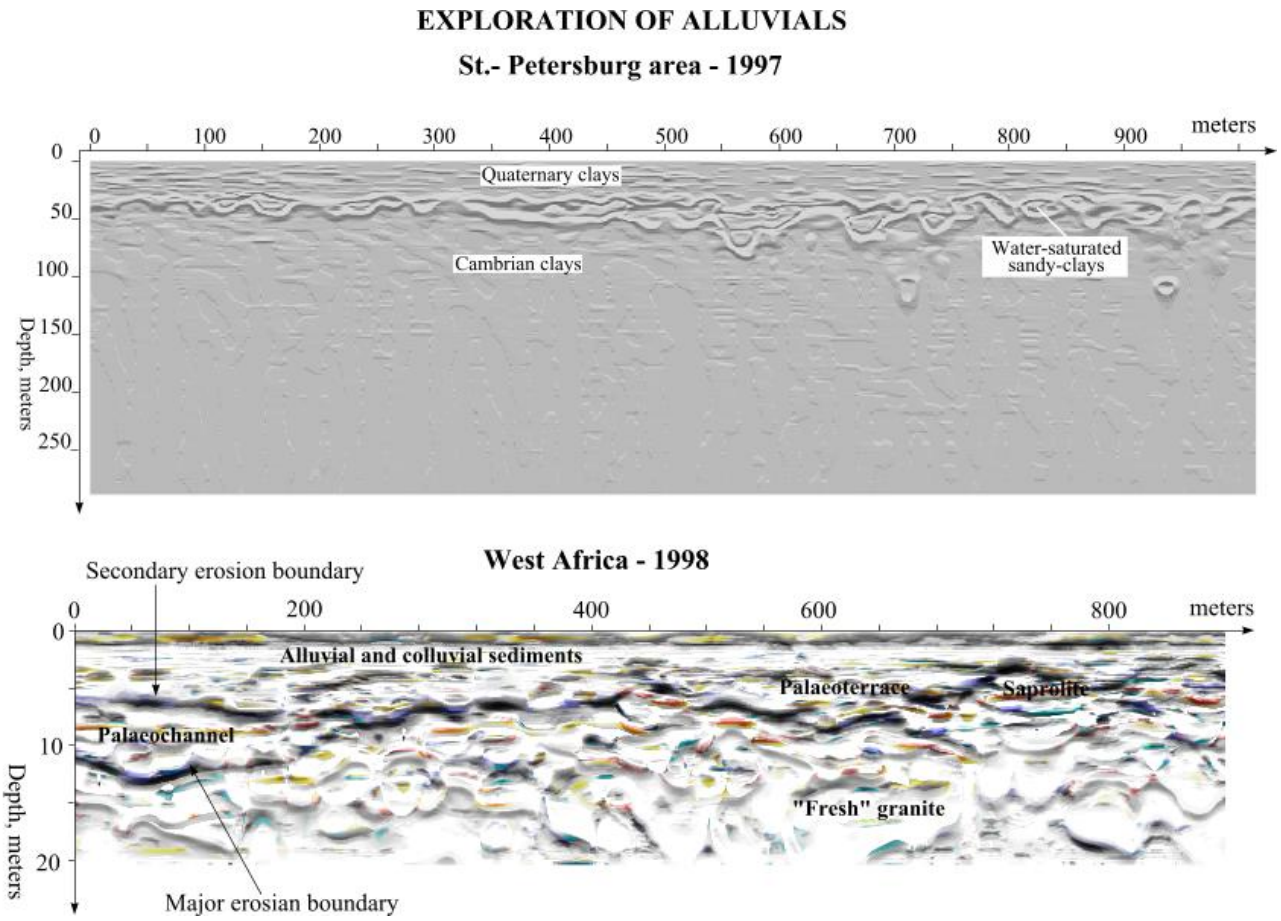
- Interpretable results are from primary data processing. Annotated, presentable, graphic results are therefore available for inspection just a few hours after gathering data.

- Final presentation is easy to read and comprehensible, even to non-professionals. It is therefore suitable for promotional and fund raising purposes and immediate use in alluvial mine planning.

- The RAP depth range is from less than 1 m to approximately 400 m. The frequencies used depend on depth of targets, surface conditions and geology. Frequencies used may be adjusted for different depths using 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 may be used as a cost-effective alternative/support to traditional geophysical techniques and core drilling in mining and exploration projects - in particular for the delineation of discovered geological bodies and search for their extensions, in testing magnetic/EM anomalies and palaeochannel exploration. There also are obvious and proven RAP applications in regolith research,
applied civil engineering, geotechnical and environmental projects. The main fields of development and practical use over the past five years have been on alluvial diamond and gold targets.

The following are examples of RAP profiles including some early examples from the 90's to demonstrate MinEx have been producing readable results for some time. Some of these profiles are deliberately not annotated to demonstrate how clear and readable they are. There are obviously many profiles available to view on further deliberation.


EXPLORATION OF ALLUVIALS
St.- Petersburg area - 1997
0
100
200
300
400
500
600
700
800
900
meters
0
50
100
150
200
250
Depth, meters
Quaternary clays
Cambrian clays
Water-saturated sandy-clays
West Africa - 1998
Secondary erosion boundary
0
200
400
600
800
meters
0
10
20
Depth, meters
Alluvial and colluvial sediments
Palaeoterrace
Saprolite
Palaeochannel
"Fresh" granite
Major erosian boundary

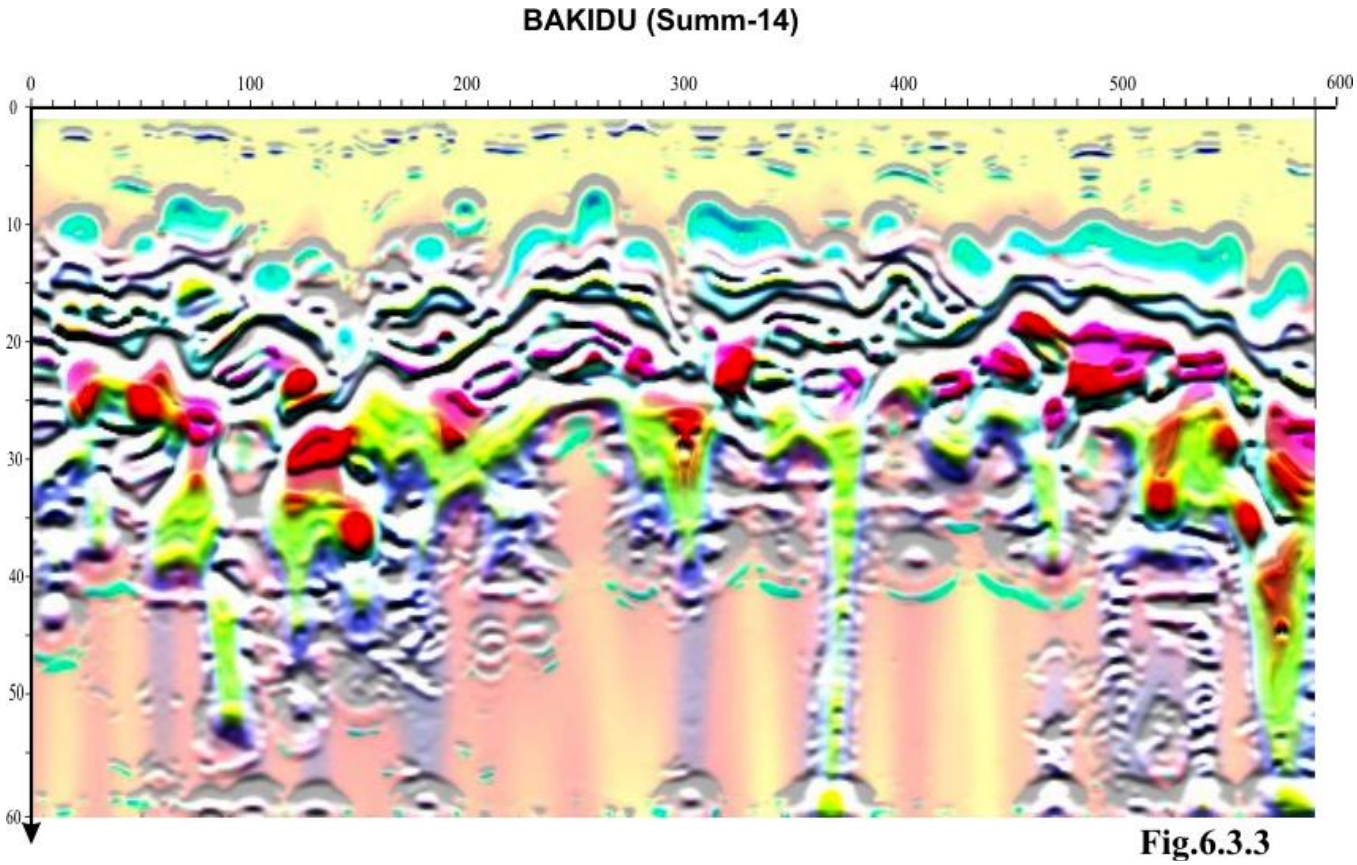

BAKIDU (Summ-14)
0
100
200
300
400
500
600
0
10
20
30
40
50
60

Fig.6.3.3

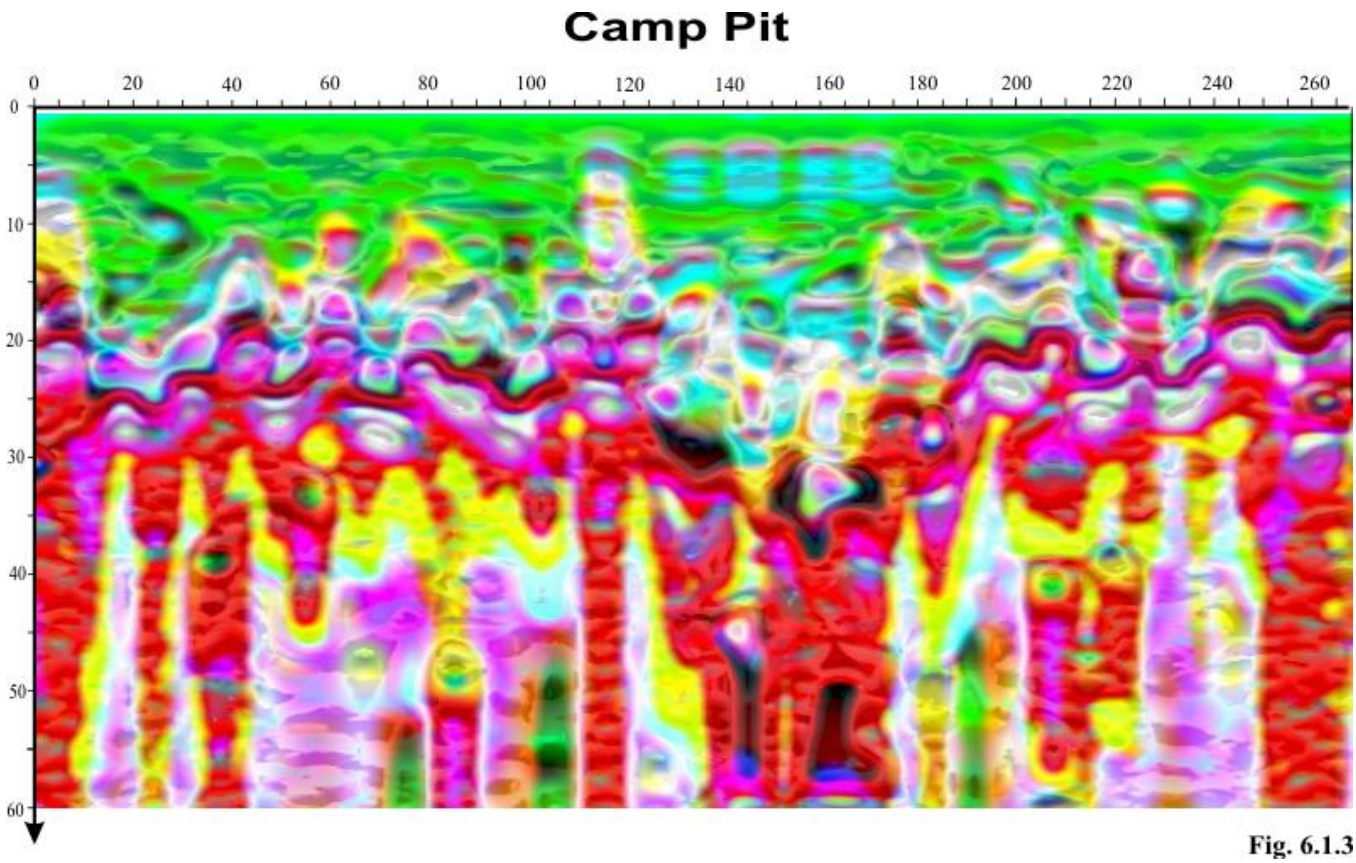
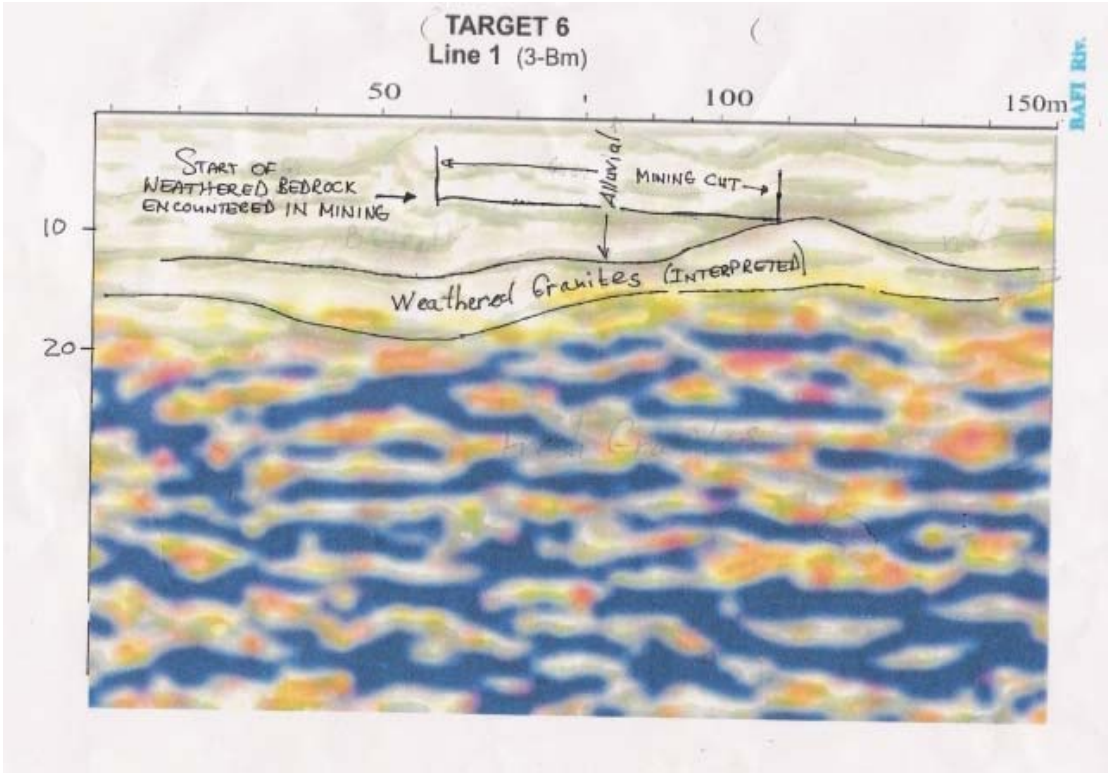


Fig. 6.1.3



Sierra Leone 2008

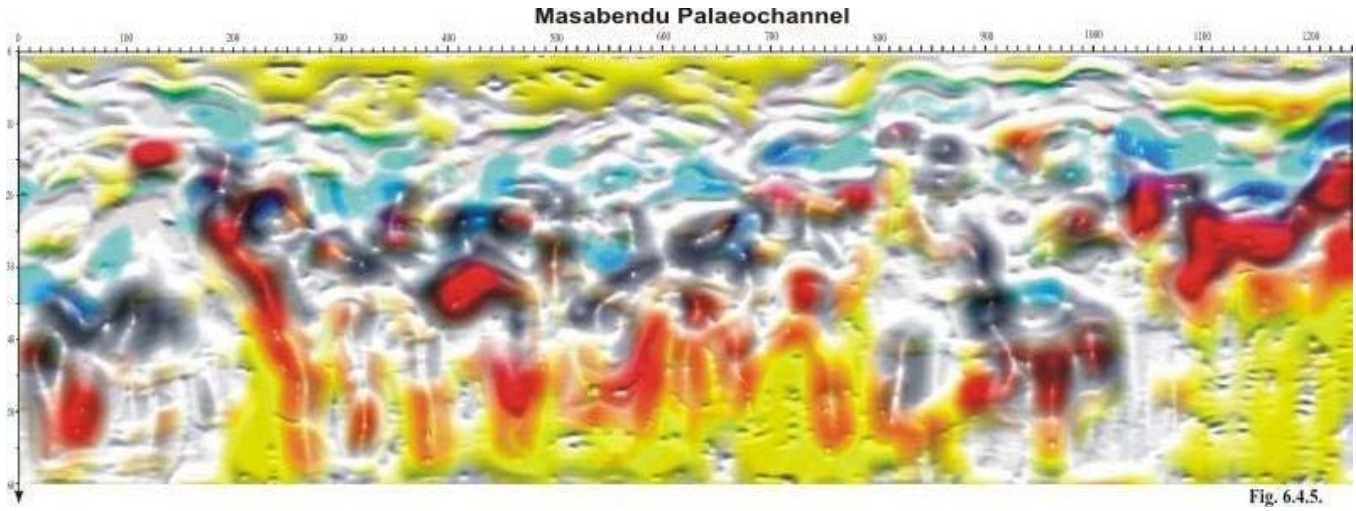


Fig. 6.4.5.

Sierra Leone 2008

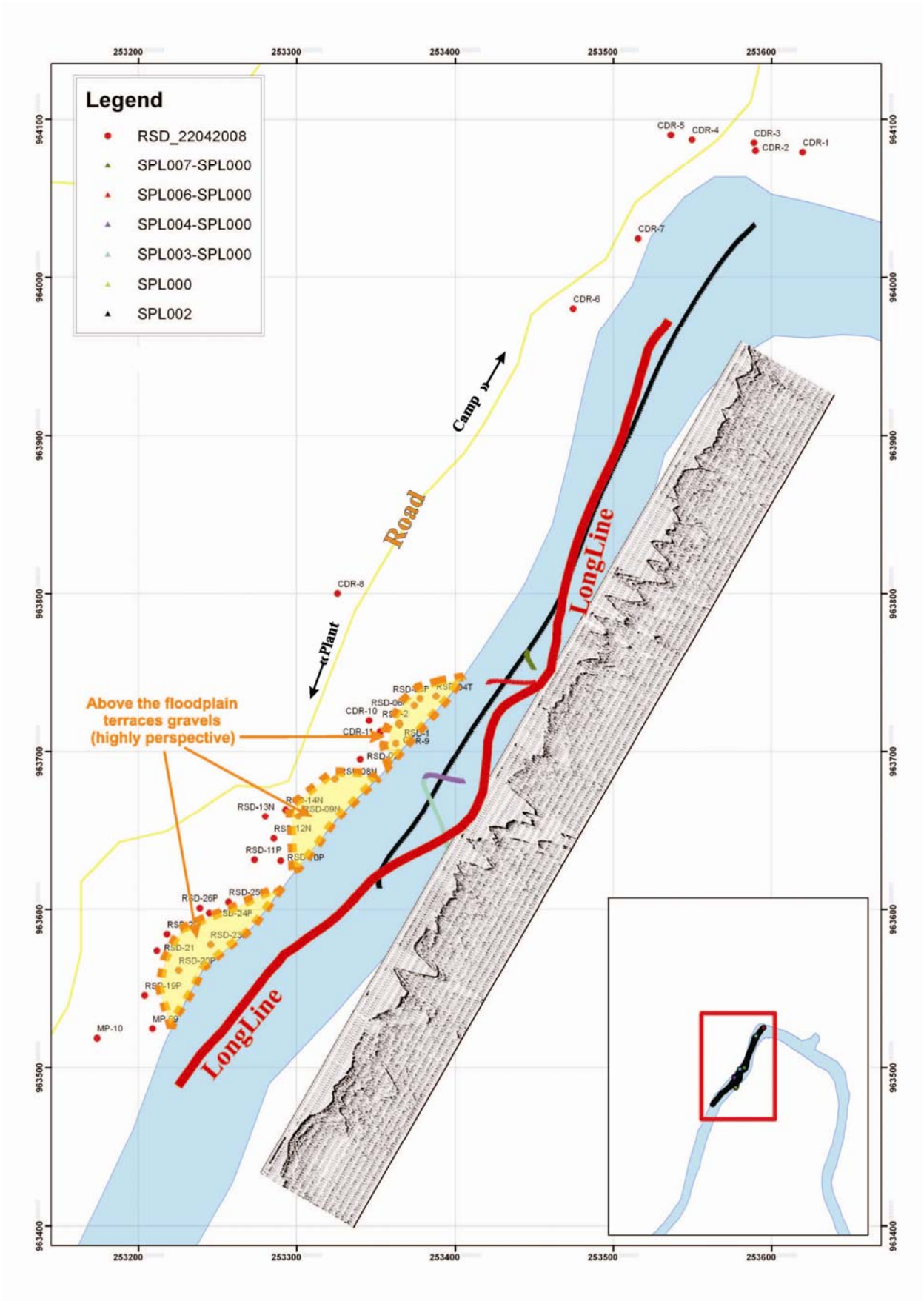
Sub Bottom Profiling (SBP)

In 2008, MinEx acquired a sub bottom profiling device and system at around $70,000 for work on rivers in Sierra Leone. The initiative was something of an experiment but was necessary as dredge targets needed to be identified. The machine proved an excellent investment. It produces excellent readable graphics detailing alluvial sub bottom features when combined with MinEx's RAP raw data processing systems. MinEx have experience with using the machine and have started to produce three dimensional images for dredging applications.

The device, manufactured to specification from a major geophysics instrument manufacturing company is ideally suited for use in rivers, lakes, ponds and shallow water ocean applications up to 300m maximum depth. The device was designed as a portable system that can be used from smaller boats and produces high image quality as larger units produced by the same company for oceanographic use.

The system operates at 2-16 kHz and provides greater penetration than other machines. Along with a towfish, the system comes with a portable splash-proof topside processor with laptop computer running and with a 35m tow cable.

The following is an example of a profile MinEx have produced by SBP, which can be easily analyzed.



Sierra Leone results, 2009, note that plan and river shape give no indication of sub bottom features, there are at least three major depressions visible. (Forgive spelling of annotation!)

Personnel

Geophysics is only as good as the team of individuals using the equipment. 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 project. MinEx have many other mineral industry specialist personnel, to meet a project's needs in future, right through to production dredging or mining and would be pleased to provide detailed CVs for any of the following upon request.

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 dredge, 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, which 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.

Zsolt Katona, BSc.
Mapping and GIS Engineer

Zsolt is a graduate of the University of Debrecen Sciences, Hungary. He is now teaching at the University and is a GIS consultant.

Over the last 10 years he have been performing various GIS tasks, field surveys(with GPS and sonar sytems), postprocessing the results(including creating geodatabase to store the data(Access) from GPS, geophysics and drilling results and other diferent sources to perform high level analysis, datum conversations and 3D modelling), producing cartographic maps, decision support, presentation,

He is an expert at creating base maps, digitizing, geo-referencing aerial and satellite photos, data conversation to from different sources to ArcGIS, dam failure modelling and other environmental applications. He is used to creating web maps, conducting field surveys, managing field survey and drilling teams, He is a proficient GIS trainer and has written a handbook on the use of ArcGIS9.x2.

He is one of the few people in the world with first hand experience of using the sub bottom profiler systems used by MinEx, on alluvial scenarios. He works closely with Valery Lazebnik to produce readable profiles and apply them to GIS applications. He is experienced in creating three dimensional models from MinEx acquired geophysics data.