

WATER WELL LOGGING AND AUTOMATIC LOG INTERPRETATION TECHNOLOGY

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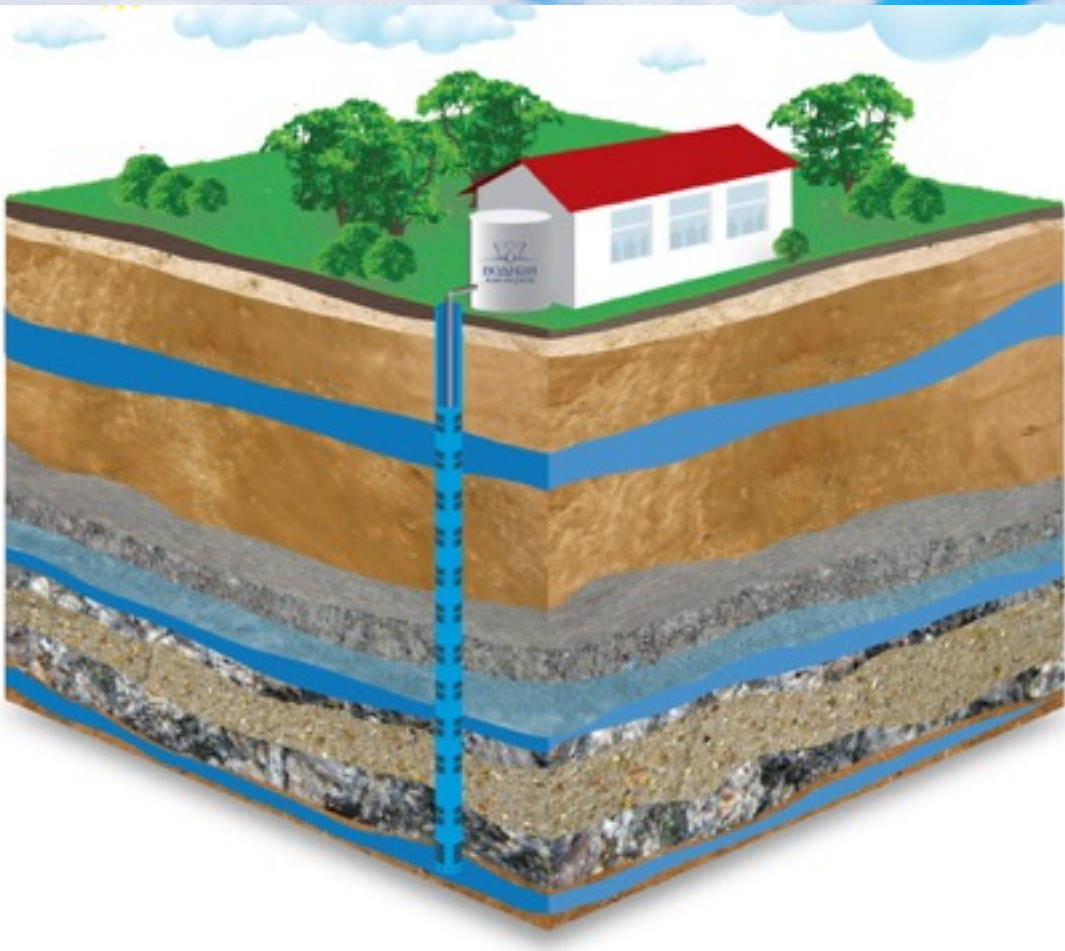


WATER WELL FEATURES

A water well is not very deep (usually not deeper than 200 m), its construction includes plastic pipes and filter(s) that is installed at an aquifer level. Hopefully.

Practically, a local well drilling operator knows the geology of his region and, based on drilling mud properties and effort that the drill bit need to drill at particular depth, he is able to discriminate the cross-section and find a proper place to set the filter.

But to get more precise information about an aquifer position and a water salinity, it is need to use WELL LOGGING.



NEW APPROACH TO THE WELL LOGGING

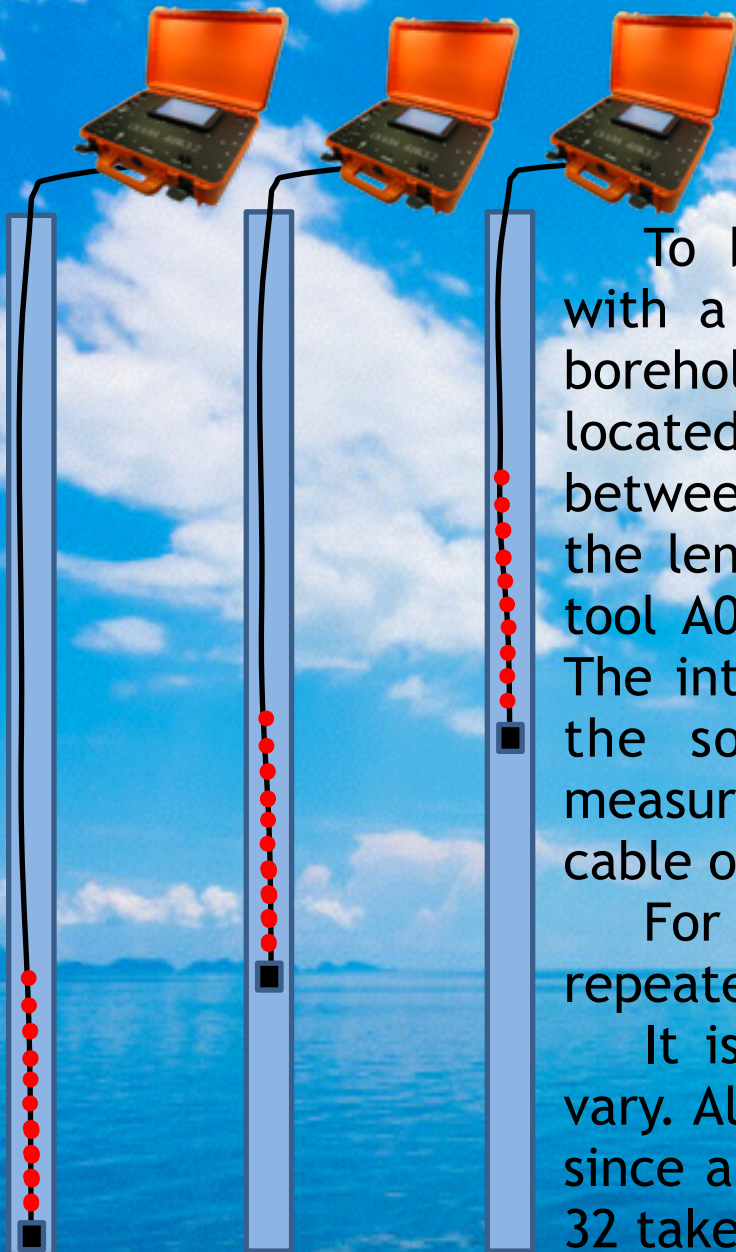
Typical set for a water well logging includes resistivity log with 1 or 2 sets of electrodes that gives resistivity of drilling mud (at small spacing) and apparent resistivity of the media, spontaneous polarisation log and gamma ray log. Hundreds of kilos of equipment to be transported to the well to produce a bench of curves that need to be interpreted by a geophysicist or hydrogeologist.

What we are going to propose is something completely different. One lightweight device with one cable with takeouts (electrodes), interactive software for the logging process and automatic interpretation software that can be used by anyone who is able to use an Android based smartphone.

The device is recording 2 curves: apparent resistivity and induced polarization.



NEW APPROACH TO THE WELL LOGGING



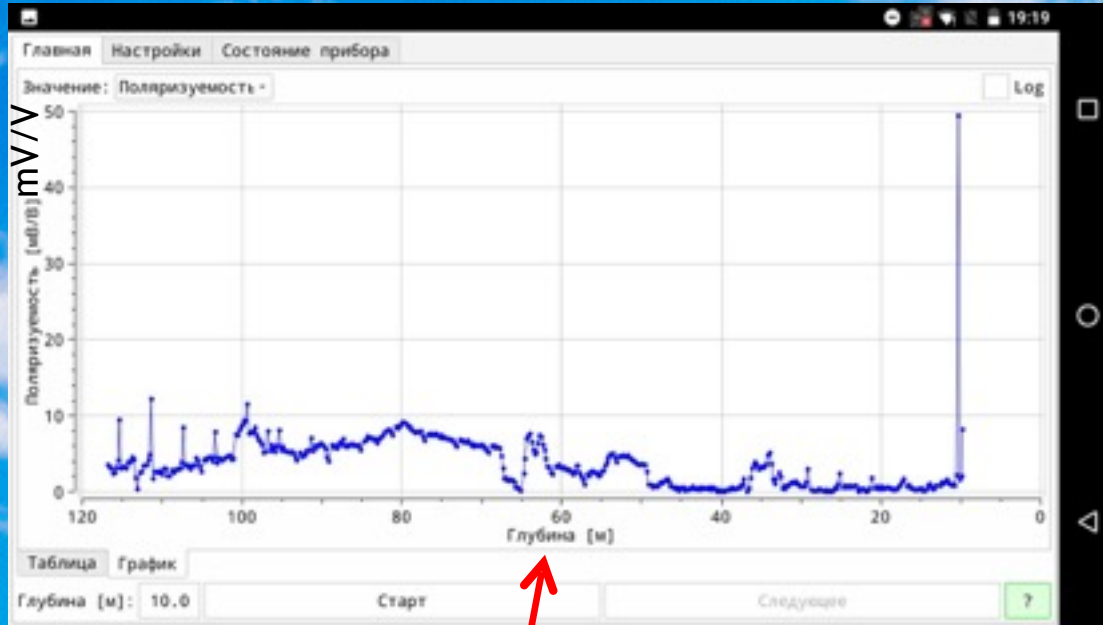
To begin the well logging, the sounding cable with a weight at the end should be put into the borehole. The takeouts (shown as red dots) are located at the bottom hole end of the cable. Spacing between them is 20 cm. There is 32 takeouts. So, the length of sounding part is 6.2 m. The sounding tool A0.2M2N can be fit into this length 22 times. The interactive software is switching the tool along the sounding cable, and after completion of measurement gives command to the crew to pull the cable out for 6.2 m.

For the 120 m well such a process must be repeated 19 times. It takes more or less 25 minutes.

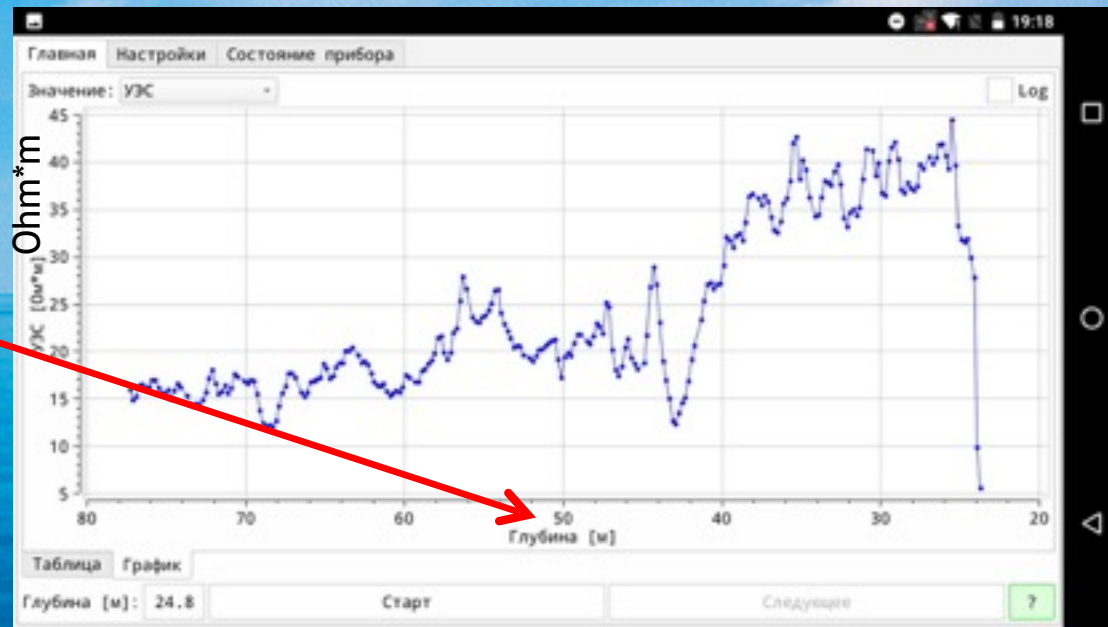
It is obvious that the length of the tool can be vary. Also the number of various tools in not limited, since all of them are virtual. Just fit your tools into 32 takeouts and total length 6.2 m.

Yes, dude....

NEW APPROACH TO THE WELL LOGGING

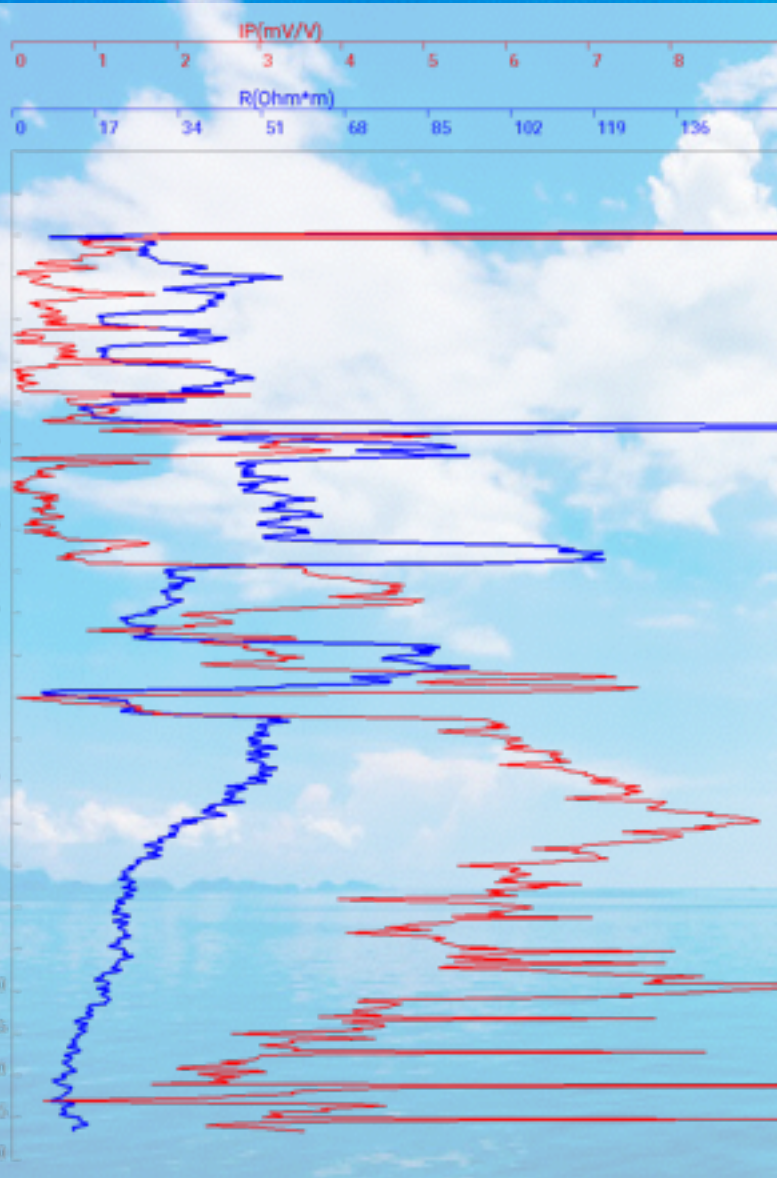


The interactive logging software screen shots are presented.
IP curve is on the left,
resistivity log is below.



Depth (m)

LOG ANALYSIS



The resistivity curve (R, blue) is recording the apparent specific resistivity of the media. In sand and clay mix the higher values caused by sand and fresh water.

The red IP curve - induced polarisation - reflects the clay percentage (clays are well polarizing media) and water saturation.

Thus, a fresh water aquifer features big resistivity and small polarization.

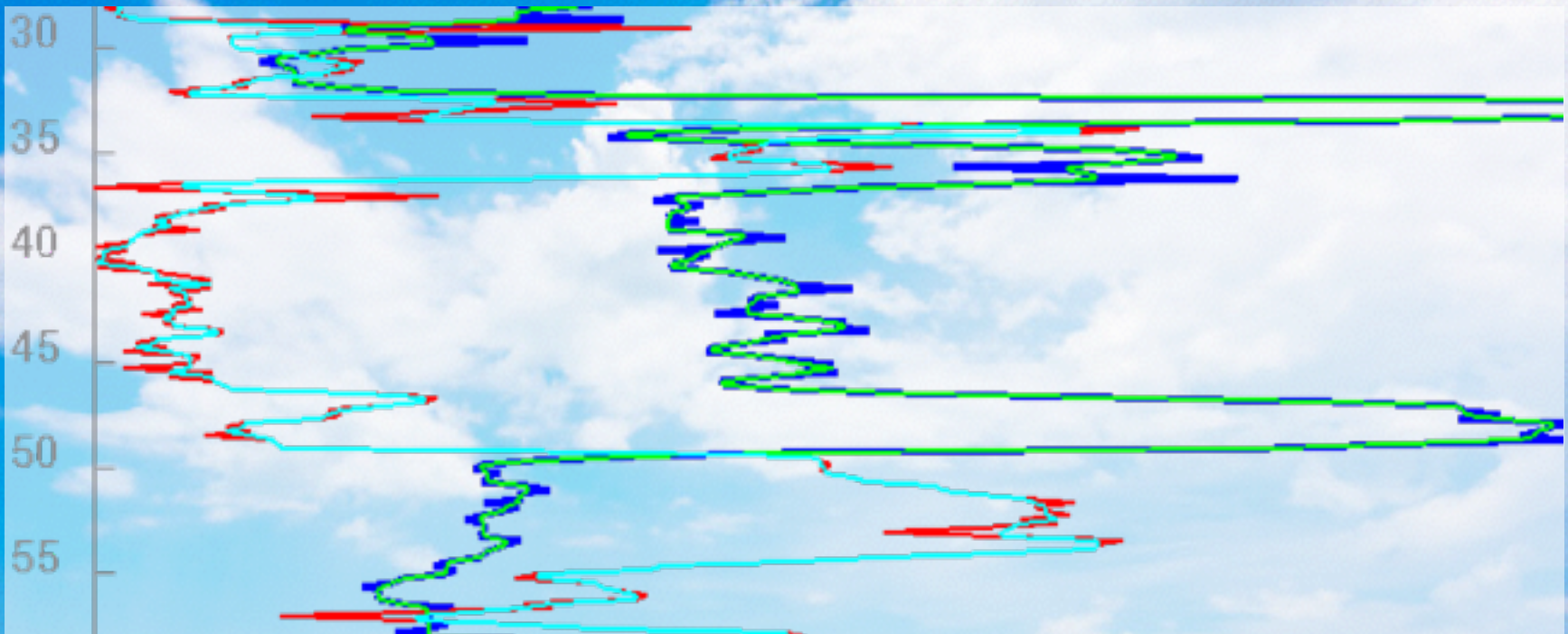
It is logic to offer a “fresh water function”

$$F_{fw} = R/IP$$

with special modernisation to avoid 0 dividing, normalization and boundary conditions.

Yes, I do understand that this function means nothing in terms of physics. It is the pure math. Yep...

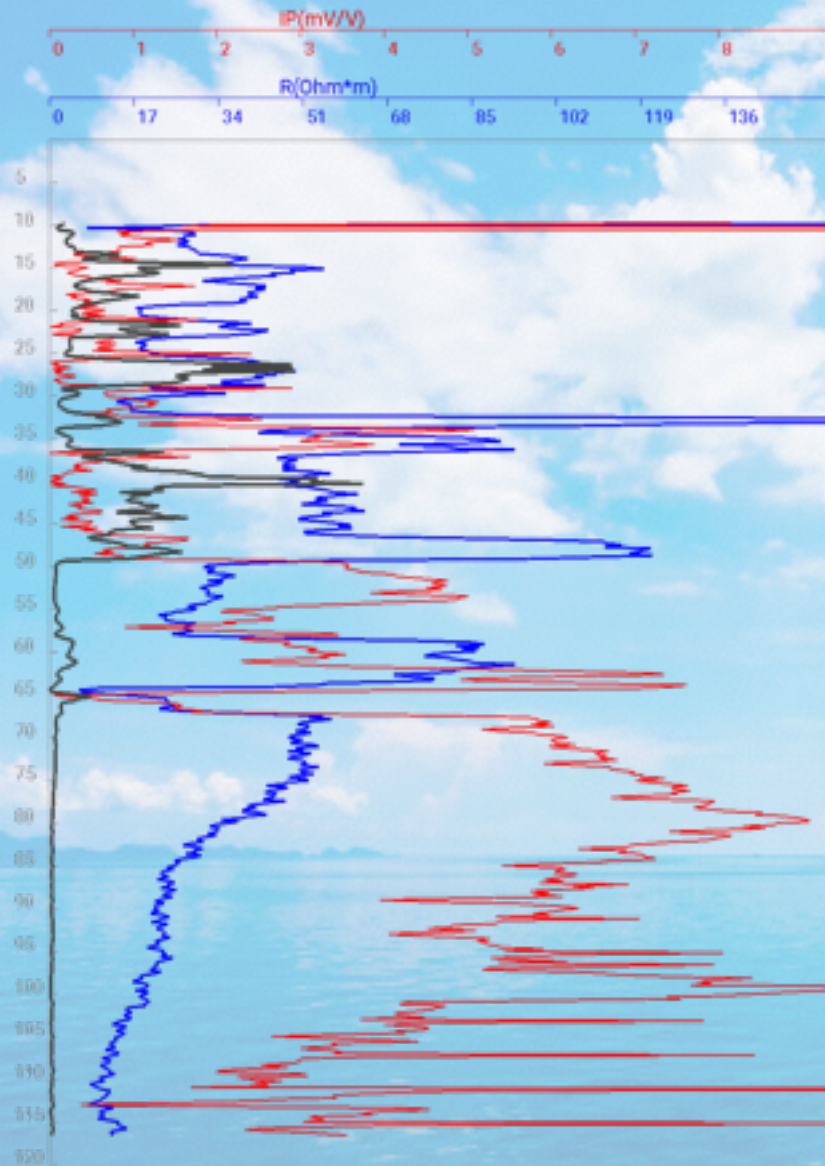
LOG ANALYSIS



The raw data can contain some noise and one-point anomalies that must be filtered out prior to F_{fw} calculation. The median filtration of R and IP curves are shown above.

LOG ANALYSIS

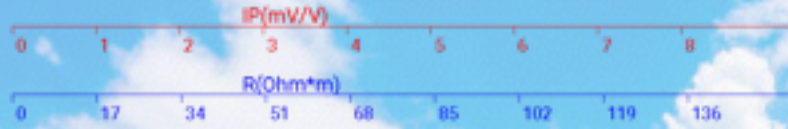
Intervals found: 2



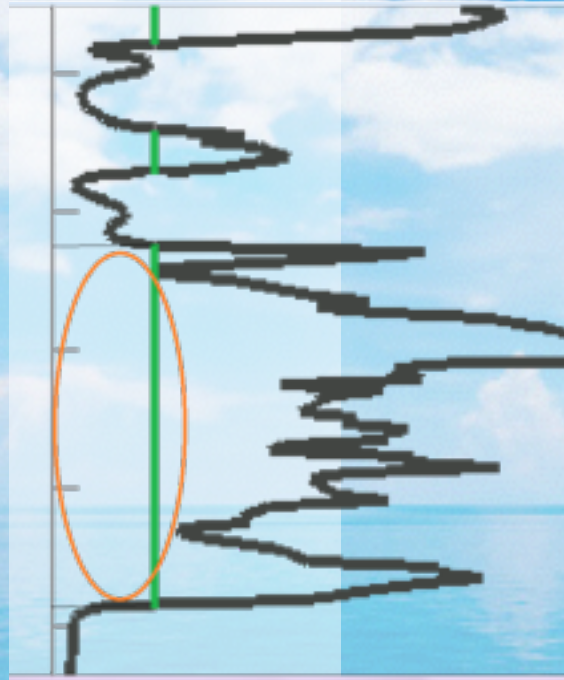
The F_{fw} curve shown in black together with R and IP curves

LOG ANALYSIS

Intervals found: 2



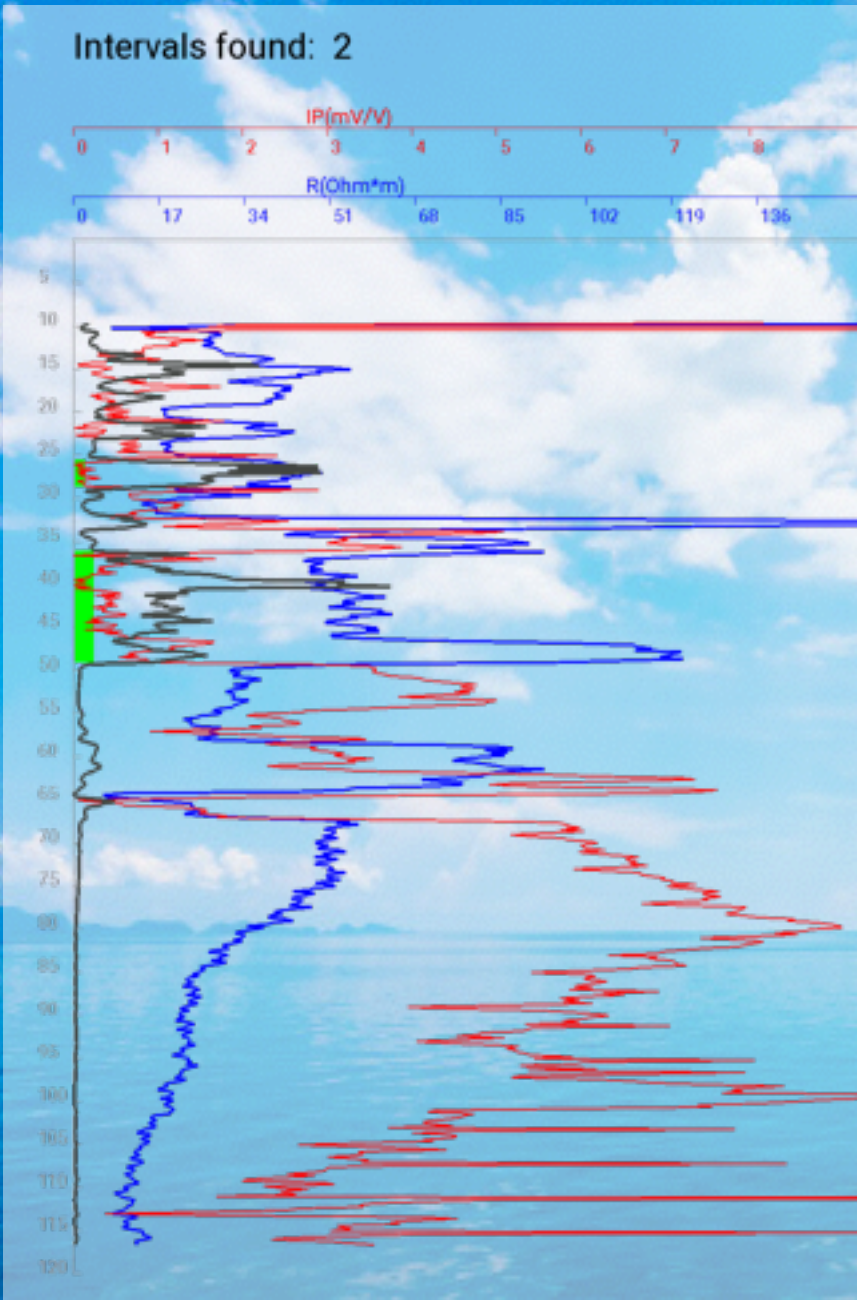
A



B

A set of F_{fw} values is chosen and an interval vor every value created (see picture A). For every interval an assessing figure is calculated that depends of maximal area with set relation of area to length. (see picture B).

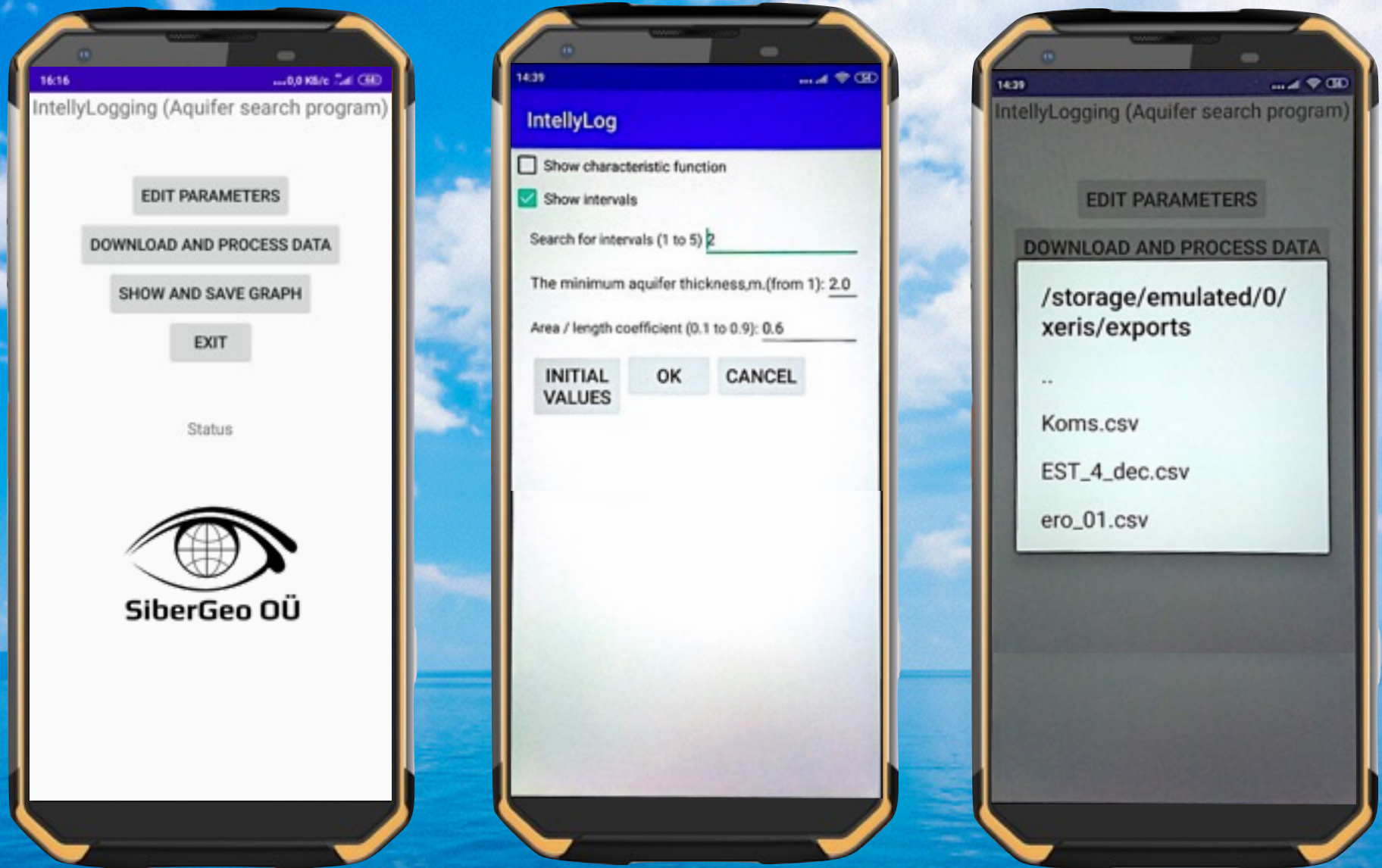
LOG ANALYSIS



Ordering intervals using assessing figures one can choose the desired number of best intervals.

Two best intervals shown as green stripes (25-29 m and 36-49 m). Wider stripe means better interval.

The Android based interpretation software



The Android based interpretation software



The result can be seen at the screen, and downloaded as graphic file and sheet with values.

CONCLUSION

- The simple technique for a well resistivity and induced polarization logging is created. The solution includes interactive android based software for the logging process. Any kind of electric resistivity imaging instrument of SibER NNkNN series is suitable for it.
- The automatic aquifer search software for Android is created. It can search the logging file data at the device and process it, giving to the drilling operator suggestion for a filter set up.
- For the moment the system tested only at sand-clay mixtures with fresh water saturated sand aquifers. This geological situation is wide spread and such an automatic suggestion can be useful for numerous cases.
- Other geological situations (water in fractured granites, in fractured limestones and other) will require other algorithms to be implemented.