Integrated Exploration Methods in Volcanic Covered Areas **CAH.1**

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Introduction

During the past decade electromagnetic techniques have been applied and evaluated for exploration under basalt cover around the world. We show several case histories from the US, Europe and Australia to illustrate a new exploration concept which involves several different electromagnetic techniques and seismic for an optimum resolution of the subsurface structure hidden by near surface basalt covers and / or carbonates. The near surface structures are resolved using loop source transient electromagnetic; the intermediate depth is resolved using grounded wire transient EM (LOTEM); the deep part using magnetotellurics (MT); all EM techniques can be constrained using seismic data. The integrated approach in interpretation significantly improves the resolution capabilities of the individual techniques.

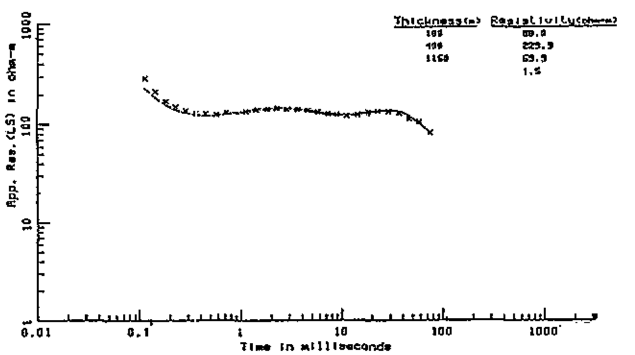

Figure 1: Typical in–loop transient sounding curve and interpreted model.

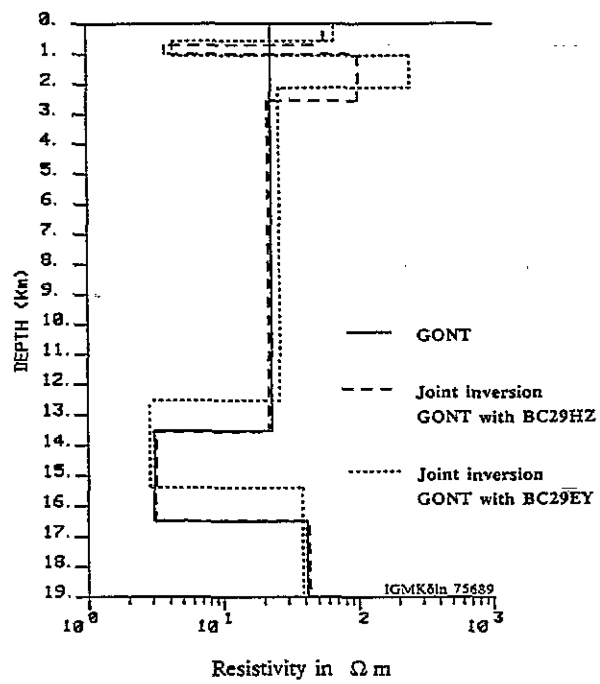

Figure 2: Joint inversion result for a basalt covered area in Central Germany

Columbia River Plateau

The first case history is from the Columbia River Plateau in Oregon (USA). It is the first survey where MT and In–Loop transient EM were integrated to obtain a "static corrected" MT section. The average thickness of the volcanics is about 1000 m and no acceptable seismic data was available for the area. High quality MT–stations have been recorded in a reasonable 1 D situation. An isohypse map of the deep resistive layer within the sedimentary series could be drawn after a proper selection of the resistivity curve at each station. It appeared however, that this map was correlated with the topography.

It was later understood that erroneous depth determinations were due to the so called static effect, related to topography. A correction was designed involving shallow in-loop transient soundings at each MT site and correcting the MT curves accordingly. Figure 1 shows a typical in-loop sounding curve which was used for correction of the MT apparent resistivities. This resulted in accurate depth determination.

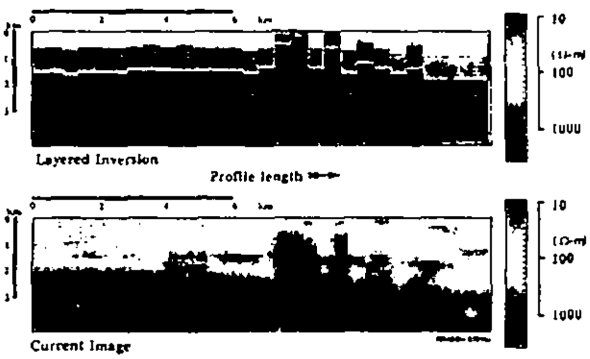

Figure 3: Imaged field data and one-dimensional inversion results

Vogelsberg, FRG

The second set of case histories is from a basalt covered area in FRG where again reliable seismic information is difficult to obtain. The combination of long offset transient electromagnetics (LOTEM) and magnetotellurics allows an accurate tie of the data to a depth of up to 10 km (see figure 2). Selective three dimensional modeling had to be performed for several data sets. This is done by first imaging the data, then inverting with a one-dimensional routine (compare figure 3), followed by more selective three dimensional forward modeling runs as displayed in figure 4. Apart from showing the sedimentary units clearly below the basalt, both examples show that even in the presence of extremely strong cultural noise and under complex geological situation the sedimentary units are resolvable.

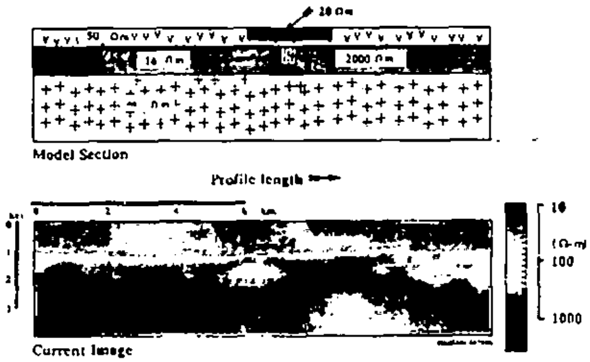

Figure 4: Three-dimensional model and image of the synthetic data for the profile in figure 3.

Australia

The next case history (numerical models) is from Australia where, similarily to the basalt problem, resistivities had to be mapped in a resistive carbonate unit at depth. Only the full combination of all techniques, namely shallow transient EM, LOTEM, MT and seismic was able to achieve the goal in this extreme case.

Conclusions

In all cases, the integration of the different EM techniques allow an accurate depth determination at shallow as well as intermediate depth. The selection of the appropriate technique depends on the resistivity structure and the depth range of the exploration target. An optimum resolution can be obtained by integrating EM-techniques with seismic and keeping the known parts of the structure fixed while focusing the interpretation on the unknown. The combination allows good structure reconnaissance despite of rugged topography, strong cultural noise and lateral heterogeneities.