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"Numerical Models and Scale Model Experiments involving  
Cylinders of High Conductivity embedded in a Low Conducting Host"

The electromagnetic response of a conducting cylinder buried in a poorly conducting host, due to the inducing fields of uniform and line current sources has been studied employing numerical models and analogue model experiments.

INTRODUCTION

The problem of the source effect in regions of localized source fields has been of considerable interest for almost three decades. The question raised has been related to the validity of Cagniard's (1953) theory in the interpretation of magnetotelluric data in regions of localized source fields, such as the auroral and equatorial electrojets. The present study was undertaken with a view to shedding more light on the practical application of Cagniard's theory in regions of localized source fields. The mathematical model which is adapted from D'Yakonov (1959) analytical solution to the problem of a buried cylinder in a uniform half-space is shown in Fig.1. It consists of a cylinder of high conductivity with its axis parallel to the x-axis, buried in a half-space of low conductivity. The fields are evaluated at points on the surface of the half-space.

Two inducing source fields are employed in the present work, namely: a uniform source (representing a global field) and a line source (representing a localized source field). Numerical results for a number of geophysical parameters of interest, such as, the source frequency, cylinder radii, cylinder to host medium conductivity contrast and depths of burial were obtained. As a check of the validity of the calculated results, numerical results for some cases for a uniform source are compared with analogue model measurements.

A detail description of the analogue model as well as the mathematical model have been given earlier by Ogunade and Dosso (1980a,b).

## RESULTS

Only the summary of the results will be given here since the detail results have been given by Ogunade and Dosso (1980a,b). It was found that for a uniform source, the conductivity and depth of burial of a horizontal conducting cylinder buried in a host of low conductivity can best be determined from a measurement of the amplitude of the horizontal electric field  $E_x$ , the horizontal magnetic field  $H_y$ , the vertical magnetic field  $H_z$  and the phases  $\psi_x$  and  $\phi_y$ . The results also indicate that the limitations in the application of Cagniard's theory are only severe for periods greater than 100s, and that for line current heights greater than 500 km, apparent resistivities are significantly smaller for line current excitation than for uniform field excitation for periods greater than  $10^3$ s.

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G. REICHNER

Die VLF-Größen: Scheinbare Sender-Richtung und maximale horizontale Magnetfeldstärke

Bei der VLF-Methode nutzt man die elektromagnetischen Signale von entfernten Radiosendern im Very-Low-Frequenz-(VLF)-Bereich (15 bis 25 kHz) aus. Diese Signale werden durch vertikale Antennen und solcher Art erzeugte primäre Wellenfelder der sinusförmigen Wechselspannung  $U = U_0 \sin(\omega t)$  in die Erde übertragen. Die primären Wellenfelder sind in der Horizontalen und senkrecht zur Richtung auf den Sender zu. Bei Anwesenheit von leitfähigem Material werden in diesem Wirbelströme induziert, welche wiederum sekundäre Wellenfelder erzeugen. Primäre und sekundäre Felder überlagern sich, wir messen im allgemeinen ein elliptisch polarisiertes Feld.

Ein wichtiger Parameter bei den Untersuchungen sind die Orientierungen zwischen dem primär polarisierten Primärfeld und der Streichrichtung der Störkörper. In einer dünnen vertikalen Platte, etwa, werden nur dann Ströme induziert, wenn eine antragende Magnetfeldkomponente senkrecht zu dieser Platte existiert. Man wird somit immer versuchen, die Störkörper zu benutzen, die möglichst gut in Richtung des Streichens der zu untersuchenden Struktur liegt.

Im wesentlichen zwei Arten von VLF-Messungen sind gebräuchlich. Die eine Größe, die bei allen Methoden gemessen wird, ist der Neigungswinkel der großen Achse der Polarisationsellipse. Die zweite Größe ist bei der einen Methode (Geomix) das Amplitudenverhältnis, bei der anderen Methode (Scintrex) die Lage einer oder mehrerer Achsen oder irgendwelcher Projektionen davon. Die Messungen werden konventionellerweise in der Ebene senkrecht zur geologischen Streichen durchgeführt.

Bei der Interpretation von Feldmessungen werden diskrete Leiter lokalisiert, indem man nach Nulldurchgängen des Neigungswinkels oder - gegebenenfalls - nach Maxima der Feldstärke sucht. Eine einfache Tiefenabschätzung gelingt mit Hilfe des Minimum-Maximum-Abstandes des Neigungswinkels oder der Halbwertsbreite der Feldstärke. Für die vertikale dünne Leiterplatte oder exakt für einen äquivalenten Linienstrom ist die Tiefe gleich der Hälfte dieses

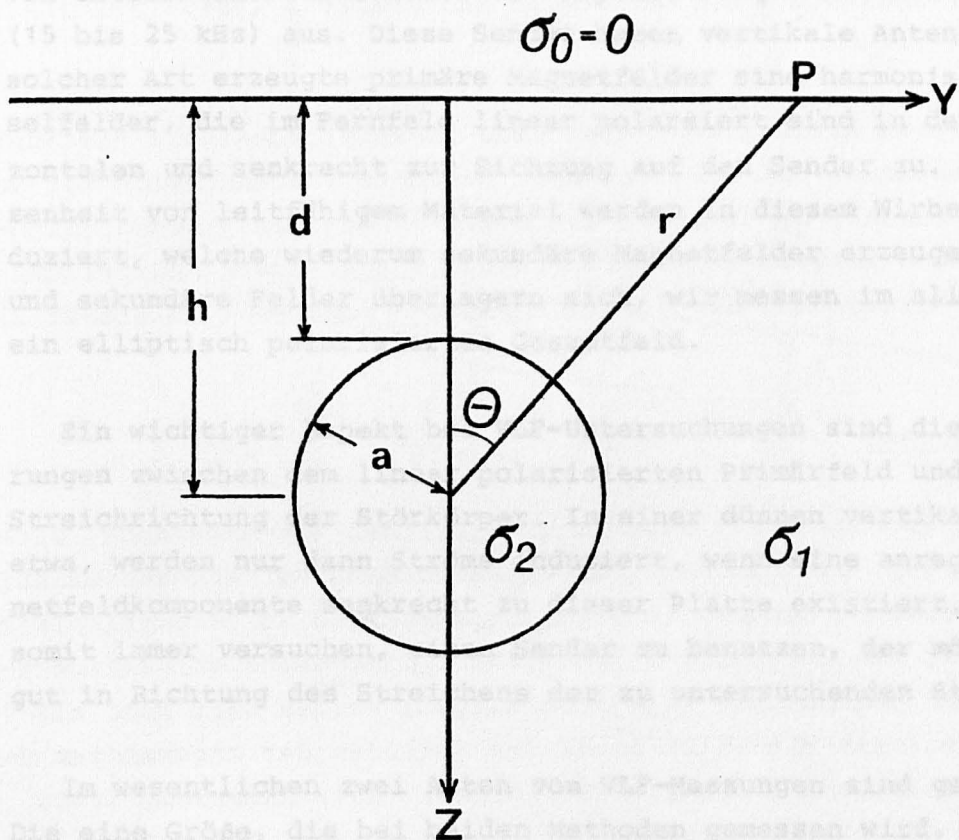


Fig.1: Mathematical Model

A detailed description of the analytical model as well as the mathematical model have been given earlier by Gagnepain and Cosco (1960a,b).

RESULTS

Only the summary of the results will be given here since the detail results have been given by Gagnepain and Cosco (1960a,b). It was found that for a uniform source, the conductivity and depth of burial of a horizontal conducting cylinder buried in a host of low conductivity can best be established from a measurement of the amplitude of the horizontal electric field  $E_x$ , the horizontal magnetic field  $H_y$ , the vertical magnetic field  $H_z$  and the phases  $\psi_x$  and  $\psi_y$ . The results also indicate that the limitations in the application of Gagnepain's theory are only severe for periods greater than 100s, and that for line current heights greater than 300 km, apparent resistivities are significantly smaller for line current excitation than for uniform field excitation for periods greater than 10's.

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