REGIONAL EM STUDIES IN THE 80's

S. E. HJELT

Department of Geophysics, University of Oulu, SF-90570 Oulu, Finland

Abstract. The review describes in broad terms the development of regional EM studies during the last five-six years. Large simultaneous magnetometer arrays, broadband and dense profiling with five component instruments, the use of remote reference techniques and in-field data processing have increased both the number and the quality of EM surveys. The increase has been strong all over the world.

An extensive list of references, divided geographically, is presented. Selected examples of regional resisitivity-versus-depth curves are shown for Africa, the Baikal region, the Baltic Shield, the Canadian Shield, the Carpathian regions, the Central Andes, Iceland, India, the Juan de Fuca Plate, the Münsterland Basin, the Rio Grande rift, the Scottish Caledonides, the Tasman Sea, and for the United States in general. Because of the influence of tectonic settings and the metamorphic grade of rocks, only qualitative aspects of the results are relevant.

'Classical' array studies, especially in Australia, in the Carpathian regions, in India, in North Germany and in Scotland have been reinterpreted and completed with more accurate 2D modelling and dense MT profiling. In the USA and Canada also new regions have been surveyed extensively. New regional EM work has been conducted extensively on the Baltic Shield and in Central and North Africa, Siberia, China, in the areas around the Caspian and Black Seas and in South America.

The newest studies are supported by or compared with other geophysical data, which also are used in extrapolating for missing EM data density. There are several successful large-scale projects in operation: the European Geotraverse (EGT), the KAPG International Geotraverses and the EMSLAB project (with its first preliminary results). Regional EM studies have been increasingly applied to geothermal, hydrocarbon and mineral prospecting as well as local structural studies, e.g. studies of sites for nuclear waste disposal.

Introduction

Electromagnetic induction studies have undergone a drastic increase in volume during the 1980's. A good demonstration of this fact is, that a computer literature search for this review gave more than 400 entries under the password 'MT surveys during 1983 or later'! It is understandable, that only a small part of this material can be included. In this review no attempt has been made to present a unified and critical summary of all the results, but merely some relevant features of studies in different tectonic and geographical settings are illustrated. The author has tried in his selection to emphasize results, which have been modelled at least 2-dimensionally. Because of the great variation of resistivity with the grade of rock metamorphism, tectonic settings etc., it is not useful to pay attention to individual values of resistivity, but instead the qualitative behaviour or the order of magnitude is emphasized in all the summarizing figures of this review.

A considerable number of of review articles and books related to the general aspects of regional electromagnetism have been published during the period 1981–1986. (Ádám, 1980/E*; Alabi 1983/E; Campbell *et al.*, 1983/E; Cox,

* The letters refer to the corresponding section in the list of references.

Surveys in Geophysics **9** (1988) 349–387.

1981/E; Edwards *et al.*, 1981/E; Fournier, 1980/E; Gough, 1983/E; Hermance, 1983/E; Jones, 1983/E; Keller, 1986a, b/D4; Rokityansky, 1982/F; Vanyan and Cox, 1983/E; Vanayan *et al.*, 1983/F). The review and book titles are found in the reference list in Sections E and F.

Induction work of today does not cover only studies in the classical sense (the crust and upper mantle, and their structure as such, on the scale of tectonic units like shields), but also various forms of inductive research techniques have been adapted for a great variety of applications. The applications often cover smaller areas, massifs, intrusions, fault zones, geothermal areas etc. with a dense network of stations. Prospecting for natural resources (minerals, oil, geothermics), and studies of sites for nuclear waste disposal are typical applications (Alperovich *et al.*, 1982/F; Strangway, 1984/E; Ward, 1983/E). One of the more exotic regional studies is involved in the test of the Gold theory of mantle-originating hydrocarbons in Precambrian bedrock (Zhang *et al.*, 1987/A1).

Due to voluminous amount of material it has not been possible to summarize in this review in necessary detail all regional studies of the world in the 1980's. It was therefore decided to concentrate on a few selected examples covering all continents and the most interesting regions of the world, to present some qualitative summarizing figures in the form of resistivity — versus — depth profiles and especially to include a (fairly) complete list of references. Besides language difficulties, quite a few studies, especially of the North American applied regional studies, are published in reports, which appear abundantly as references — but are not easily available. The lists of references have been arranged geographically.

The development in instrumentation has been favourable during the period in question. Large simultaneous magnetometer arrays and dense profiling across interesting conductive structures using MT techniques are typical of regional studies today. A great number of field groups have started use of remote reference techniques and in-field data processing (at least for preliminary work). It is also commonplace to measure all 5 field components during MT surveys.

Mainly in practical applications of the MT technique the use of active (or controlled) sources has gained in success. For crustal studies large generators, most notably the MHD ones developed in the U.S.S.R. (e.g. Velikhov *et al.*, 1986/A1), transatlantic telephone cables (Roy *et al.*, 1985/E) and power lines (McCollor *et al.*, 1982, 1983/D1) have been in use. Since commercially available instruments are rather expensive, many university groups have designed their own instrumentation (e.g. Edwards *et al.*, 1985/D1). Lack of standardization has clearly been a problem in projects where several groups perform measurements in the same area (Hutton 1985/A5).

Typically regional induction studies are increasingly using other than electric data during the interpretation stage, although joint inversion in the strict sense of the phrase has rarely been used. The emphasis on geotraverse type of research efforts all over the world has been favourable in this respect. Other geophysical data can also be used succesfully in extrapolating scarce EM data (Hermance *et al.*, 1986/D4). Also attempts to discuss and to understand in detail the tectonic and geological significance of conductive structures and anomalies have greatly increased the value of induction studies for all Earth scientists. The possibility of correlating resistivity models with data from deep boreholes (Büchter, 1984/A3; Jödicke, 1984/A3, 1985/A3) and studies in tectonically active regions like Iceland (cf. Reference Section D2) have been most rewarding in this respect.

Projects, where EM studies are involved, exist on all continents, most of them being related somehow to the International Lithosphere Program (cf. Reference Section A6). Some results from the EGT and KAPG International Geotraverse work are included in the examples of this review, whereas results from the largest EM effort, the EMSLAB project, will be discussed elsewhere.

The emphasis of regional EM studies in the 80's can be said to be twofold: Firstly there has been reconsideration of 'classical' magnetometer array studies by means of reinterpretation, more accurate modelling and dense MT profiling across interesting conductivity anomalies. Such aspects can be clearly seen for studies in Australia (+ Japan and the Pacific, cf. Reference Section A6), in the Carpathians and its surroundings (cf. Reference Section A2), in India (cf. Reference Section B1), in North Germany (cf. Reference Section A3), in Scotland (cf. Reference Section A4), in the U.S.A. (cf. Reference Section D4) and in Canada (cf. Reference Section D1).

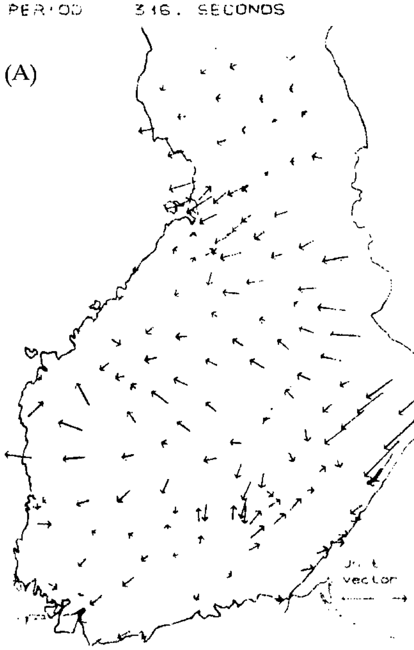
Secondly new areas have been covered both by array studies and detailed structural mapping of various kinds. The greatest activity seems here to have been concentrated in the Baltic Shield (cf. Reference Section A1), in Central and North Africa (cf. Reference Section C), in South America (cf. Reference Section D3), in China (cf. Reference Section B3), in Siberia (cf. Reference Section B2), as well as in southeastern parts of Europe and in southwestern parts of Asia.

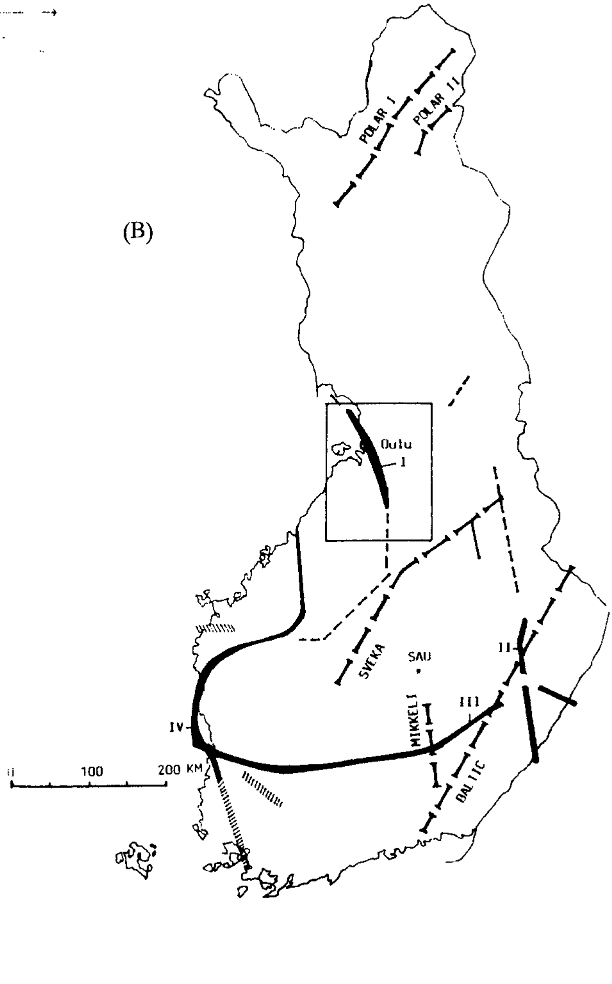
The improvements in numerical modelling techniques, although not covered in this review, are of the greatest importance in regional studies. Advances have been reported in thin-sheet modelling (Kaikkonen, 1983/A1, 1986/E) and some promising formal interpretation strategies have been presented (a.o. Berdichevsky and Zhdanov, 1985/E; Zhdanov and Frenkel, 1983/E). Perhaps the majority of regional studies already include 2D models of the most important structural features, whereas good, practical 3D modelling is still problematic.

Europe

THE BALTIC SHIELD

One of the most systematic regional studies of the 80's has been reported from the Baltic Shield, where intense MV array studies have been performed since 1981. The measurements are continuing on the western (Swedish) part of the shield (cf. Pajunpää, 1983/A1, 1984/A1, 1986/A1, Pajunpää *et al.*, 1983/A1; Hjelt *et al.*,


PERIOD 316. SECONDS
(A)
vector


(B)
POLAR I
POLAR II
Oulu
I
SVEKA
SAU
II
III
MIKKELI
IV
BALTIC
0 100 200 KM

(C)

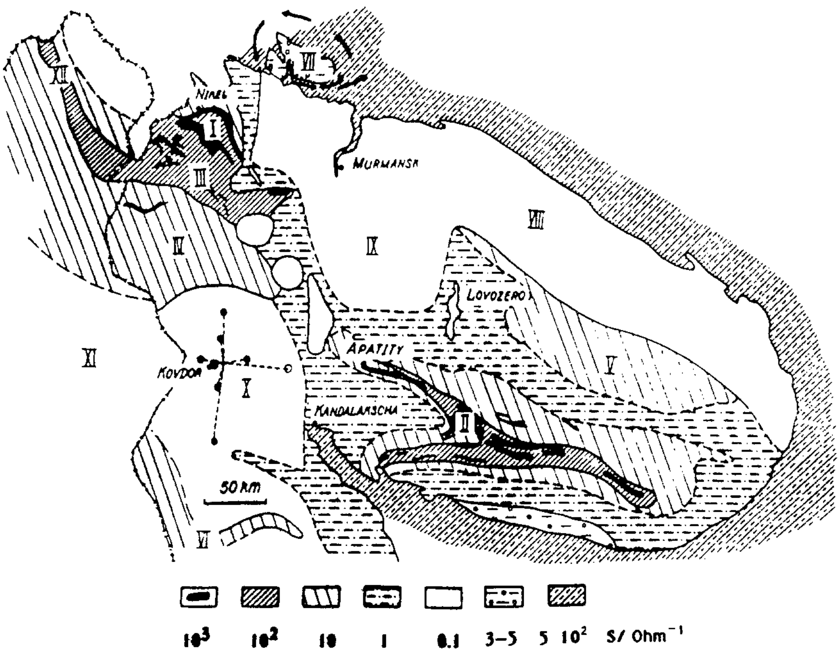


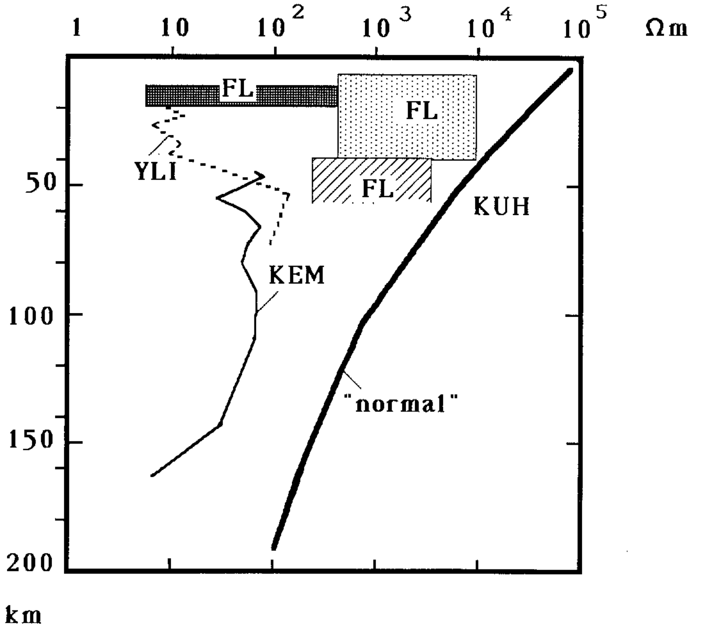
Fig. 1. Examples of the results of induction studies in the Baltic Shield. (A) Reversed induction arrows at $T = 316$ s (Pajunpää 1986/A1). (B) MV condictivity anomalies (Hjelt 1987/A1, adapted from Pajunpää, 1987, in preparation). (C) The S-map for first 10 km of the crust obtained by magnetohydrodynamic soundings (MHDS) (Velikhov *et al.*, 1986/A1).

1986/A1). The array studies found several long bands of good crustal conductors (Figure 1). The upper surface of the conductors starts somewhere between 6 and 12 km and they are several tens of kilometers wide. Complementary MT profiles across relevant crustal anomaly regions are under interpretation (Korja, 1983/A1; Korje *et al.*, 1986/A1; Zhang *et al.*, 1983/A1). Of these the Oulu anomaly has been rather well modelled and seems to require an exceptionally good conductor (0.5 Ω-m) from a depth of 6 km (cf. Figure 2). Controlled source studies have been undertaken using the MHD generator on the Kola Peninsula (Gorbunov *et al.*, 1979/A1, 1982/A1; Velikhov *et al.*, 1983/A1, 1984a/A1, 1984b/A1, 1986/A1; Heikka, 1983/A1; Heikka *et al.*, 1984/A1). Results of these and earlier studies have been summarized in several papers (Hjelt, 1984/A1, 1987/A1; Hjelt *et al.*, 1986/A1) and in two summarizing reports. A monograph concerned with the Finnish-Soviet joint studies during 1981-1986 is under preparation.

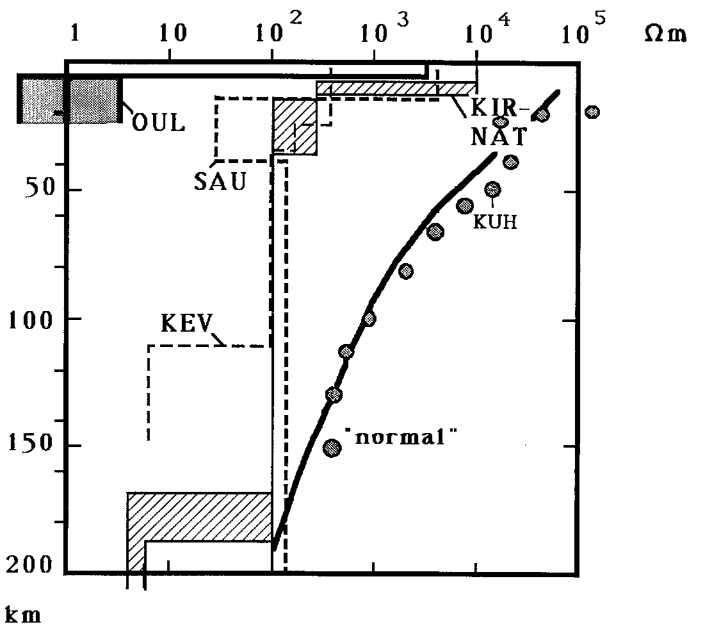
Rather extensive EM studies had previously been performed in the 70's in the Kola Pensinsula and in the Soviet Karelia (Zhamaletdinov, 1982/A1, 1984/A1; Golod *et al.*, 1983/A1; Krasnobaeva *et al.*, 1981/A1). The results include S-maps of the Kola Peninsula, the location of the Ladoga crustal anomaly and some proposed regional average resistivity curves (cf. Figure 1C).

Related results exist from the NW part of the Shield, where Jones (1981/A1,

(A)


1
10
10 2
10 3
10 4
10 5
Ωm
FL
FL
FL
YLI
KEM
KUH
"normal"
50
100
150
200
km

(B)


1
10
10 2
10 3
10 4
10 5
Ωm
OUL
KIR-
NAT
SAU
KUH
KEV
"normal"
50
100
150
200
km

(C)

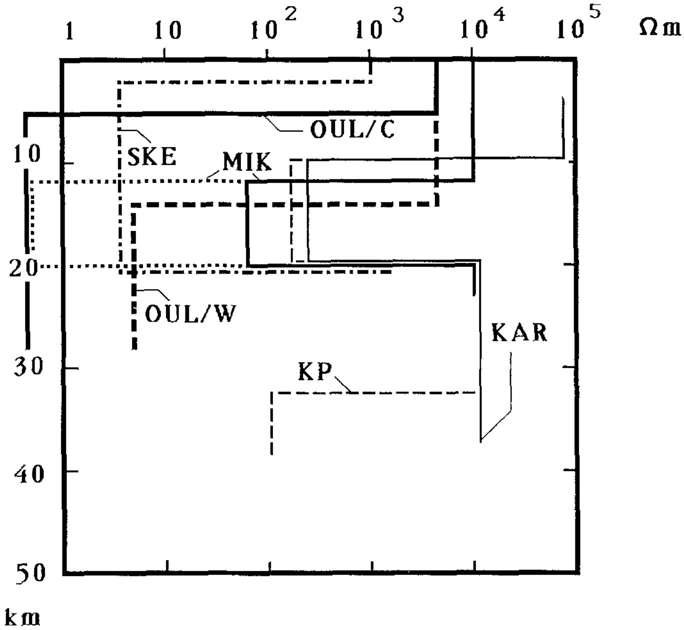


Fig. 2. Qualitative profiles of resistivity versus depth for the Baltic Shield. (A) Selected regional curves, central shield. FL = generalized results (shaded area indicating range of variation) along the Fennnolora deep seismic soundings (DSS) profile through E. Sweden (Rasmussen *et al.*, 1987/A1), KEM = Kemijärvi, N. Finland (adapted from Pajunpää, 1987, in prep.), KUH = Kuhmo E. Finland, data points vary around the averaged 'normal' curve (Kaikkonen *et al.*, 1983/A1), YLI = Ylivieska, C. Finland (adapted from Pajunpää, 1987, in prep.). (B) Regional curves, northern shield obtained by Jones (1981—1983/A1, mainly using the Horizontal Spatial Gradient technique). KEV = Kevo, N. Finland, KIR = Kiruna, N. Sweden, NAT = Nattavaara, N. Sweden, SAU = Sauvamäki, Central Finland, For comparison: OUL = Oulu anomaly cross section. (C) Selected conductivity anomalies. KAR = C. Soviet Karelia (Vagin *et al.*, 1985/A1), KP = Kola Peninsula (Vagin *et al.*, 1985/A1), MIK = Mikkeli anomaly, Central Finland (Pajunpää, 1986/A1), OUL = Oulu anomaly N. Central Finland (Korja *et al.*, 1986/A1; Zhang *et al.*, 1983/A1), SKE = Skellefte area, N. Central Sweden (Rasmussen *et al.*, 1987/A1).

1982a/A1, 1982b/A1, 1983/A1) and Jones *et al.* (1983/A1) have analyzed in many ways the IMS magnetometer array data from the late 70's and defined a conducting asthenosphere in Northern Scandinavia (Figure 2B). Osipova *et al.* (1987/A1) have recently pointed out the possibility of an alternative explanation of these data. The source effect problem has gained considerable attention both through direct modelling to set up the limits of a reasonably realistic ionospheric current arch and by using controlled source techniques. Korja (1986b/A1) has used the semipermanent (EISCAT) magnetometer chain for qualitative control of the plane wave conditions of the MTS interpretation along the EGT Polar profile. The region around Kuhmo in eastern Finland gives sounding results most closely related to the undistorted 'normal' resistivity- versus -depth curve for the Shield. (Figure 2A and 2B)

In connection with the EGT studies in Scandinavia a long MT traverse along the FENNOLORA DSS (deep seismic sounding) profile in Sweden and further detailed studies across interesting anomaly regions have been undertaken by the Uppsala group (Rasmussen, 1987/A1; Rasmussen *et al.*, 1983/A1, 1987/A1; Roberts *et al.*, 1983/A1, 1985/A1). Since the distance between the sounding points along FENNOLORA is rather large (40—60 km), only preliminary average values can be given (cf. Figure 2).

NORTHERN GERMANY

EM studies in Germany have a long and famous tradition. In the context of the EGT project the results will be summarized (Berktold *et al.*, 1984/A3; Berktold, 1986/A6; Haak, 1985a/A6, 1985b/A6) in unified presentation. Some new information has already been obtained, when Jödicke (1985/A3) and his coworkers were able to identify two separate crustal conducting layers along a NNW-SSE profile in the Münsterland Basin starting from Köln (Figure 3).

Comparison of EM data with deep borehole results (Büchter, 1984/A3; Jödicke, 1984/A3, 1985/A3) together with microscopic studies of the borehole samples has shown the importance of mineral texture and fabric plus submicroscopic film connection between particles for the explanation of the low resisitivity layers.

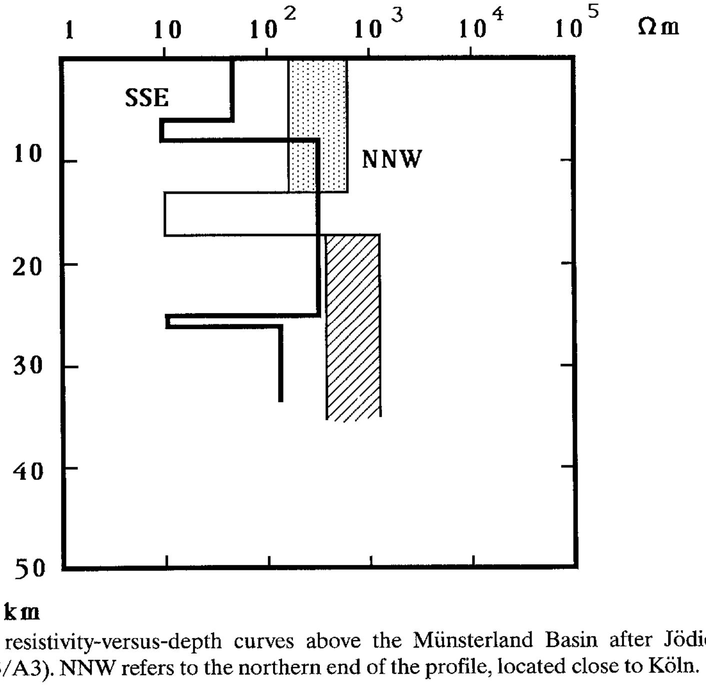


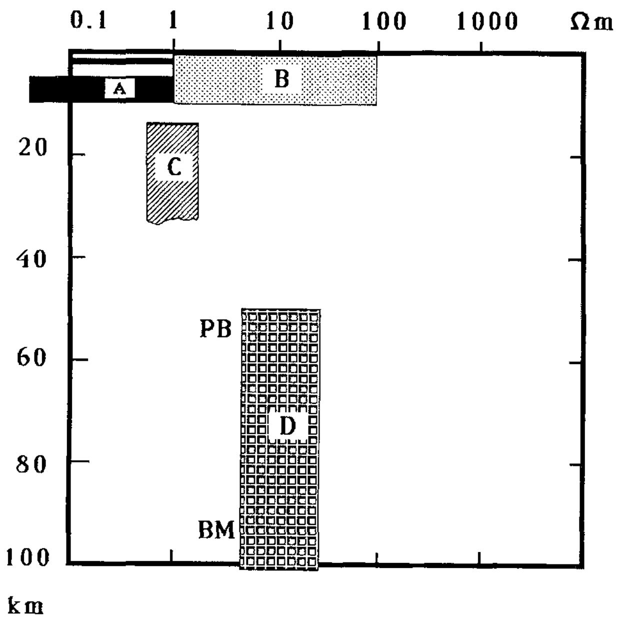
Fig. 3. Selected resistivity-versus-depth curves above the Münsterland Basin after Jödicke *et al.*, (1983/A3). NNW refers to the northern end of the profile, located close to Köln.

THE CARPATHIAN REGION

The Pannonian Basin and the surroundings of the Carpathian arch have been intensively studied targets since the beginning of electrical studies in eastern Central Europe (cf. Figure 4A for a summary of the conducting regions). The understanding of the structure of these tectonically active regions has been approached by scientists from several countries working in close co-operation: Hungary (Ádám, 1981/A2, 1985a/A2, 1985b/A2; Ádám *et al.*, 1983/A2, 1984a/A2, 1984b/A2, 1984c/A2), Poland (Jankowsky *et al.*, 1980/A2, 1985/A2; Bromek, 1982/A2), Czechoslovakia (Praus *et al.*, 1981/A2, 1982/A2; Červ *et al.*, 1984/A2; Pěč *et al.*, 1980/A2; Petr *et al.*, 1984/A2, 1985/A2, 1987/A2; Pichá *et al.*, 1984/A2) and the U.S.S.R. (Rokityansky *et al.*, 1984/A2; Zhdanov *et al.*, 1983/A2, 1984/A2, 1986/A2); recently also Austrian colleagues have participated (Ádám *et al.*, 1981/A2, 1984a/A2, 1986a/A2).

The conductivity structure of the Carpathian arch varies considerably from the E to the W part (Figure 4B). A new crustal anomaly has been reported in the latest results of the Czech MV array studies, but details of the structure have not yet been published. The most interesting findings of the Hungarian studies come from their extension towards the Austrian Alpine region. It has been possible by MTS to follow the Periadriatic lineament, despite topographic and man made noise problems (Ádám *et al.*, 1981/A2, 1984a/A2, 1986a/A2, 1986b/A2).

(A)



(B)

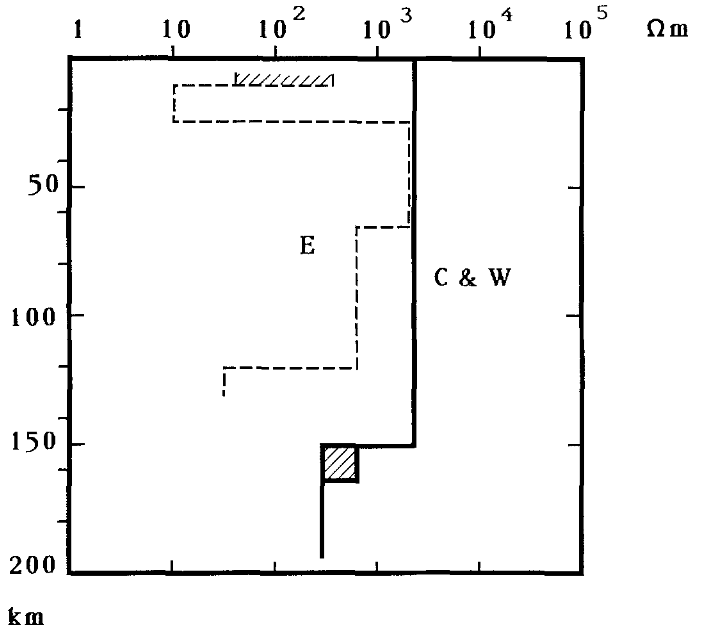


Fig. 4. Qualitative resistivity-versus-depth structures in the Carpathian region. (A) Qualitative indication of conductive zones (after Ádám, 1985b/A2); (A) Graphitic upper crustal conductor; (B) Transdanubian sediments; (C) Carpathian anomaly (melting granite + water; fluids in pores); (D) Mantle conductors (asthenosphere, partially melting periodotite); PB = Pannonian Basin, BM = Bohemian Massiv. (B) Cross-section above the Carpathian arch (from Zhadanov *et al.*, 1986/A2); C, E, and W refer to Central, Eastern and Western parts of the profile across the Soviet Carpathians.

British isles

The regional studies of the British Islands have continued at a regular pace, mostly by scientists of or at least associated with the Edinburgh school of EM studies (for a recent summary, see Hutton *et al.*, 1984/A4). Some selected vertical conductivity sections are presented in Figure 5. The Scottish array studies have been complemented by broadband MTS along selected profiles, the structural models have been improved and algorithms have been developed for 2D inversion. The Edinburgh school has been the main advocate of small site separation in *all* inductive studies. (Hutton *et al.*, 1980/A4, 1981/A4, 1983/A4; Beamish, 1985/A4, Beamish *et al.*, 1983/A4). It is a pleasure to see this approach become more and more accepted, when all realize its benefits in controlling the numerous problems, e.g. surface conductors and 2D/3D structures, involved in any regional (and even more local) induction study.

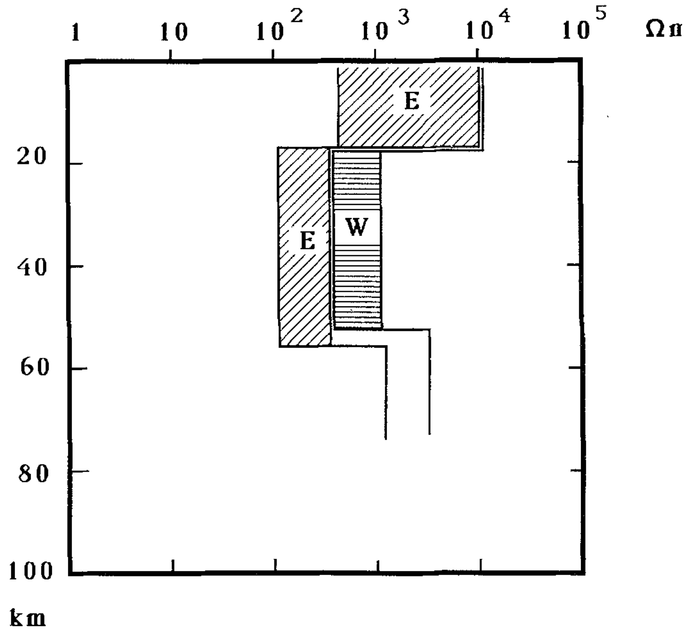


Fig. 5. Qualitative resistivity-versus-depth profiles for the Scottish Caledonides, the metamorphic zone (from Hutton *et al.*, 1983/A4). (E) = region between the Highland Boundary Fault and the Great Glen Fault (W) = region between the Great Glen Fault and the Moine Thrust. The Great Glen Fault itself is modelled as a region of 100—300 Ωm down to the mantle boundary at approximately 50 km.

GEOTRAVERSES AND RELATED STUDIES

EGT

The European Geotraverse (EGT) is a multidisciplinary project, including EM regional studies, trying to establish a crustal cross-section along a profile starting from the African Mediterranean coast to Northern Scandinavia. The profile consists of three segments: Southern, Central and Northern. For the Central section a collection of data for a unified report is proceeding as mentioned above. Unification of instrumentation for long period studies has been proposed by Haak (1985/A6.1).

To the West of the EGT/Central section, but parallel to it, interesting crustal studies have been performed in connection with the French crustal reflection study ECORS. Gazes *et al.* (1986/A6.2) and VanNgoc (1986/A6.2) have reported results from a 15 station MT profile crossing the Paris Basin. The Hercynian crust can electrically be divided into 3 parts, the two northernmost containing conductive layers of 40—60 Ωm lying deeper than 10 km in the North and between 5—10 km in the central part. A still more conducting layer is related to the bottom of the mesozoic basin (5—10 Ωm, h $<$ 1 km). A resistivity of 400 Ωm is reported for the bottom part of the crust.

The Northern Segment of the EGT crosses the Baltic Shield and has already been described. MV array work as well as selected MT profiling is continuing in the Swedish part of the Shield.

THE TRAVALE GEOTHERMAL PROJECT

The Southern segment of EGT is parallel to, but West of the Toscana (Tuscany) area, where an intensive, multinational EM study was performed in connection with the European Geothermal Project (cf. the references in Section A5, including the descriptive summary of Hutton, 1985/A5). Although many common electrical features were reported, the problems of nonuniform instrumentation and data processing is evident in many of the reports of this project.

KAPG INTERNATIONAL PROFILES

A similar, but perhaps more systematic approach has been in operation for a long time among the East-European countries in the framework of the KAPG organization. Originally based mainly on DSS studies, the KAPG International Geotraverses increasingly now include also regional EM data. In particular EM results have been reported along KAPG Profiles in the Black Sea and the Caspian Sea areas (Abramova *et al.*, 1984/A2; Ingerova *et al.*, 1986/A6.3) and also in the Carpathians and the North-Poland-region (Stănică *et al.*, 1982/A2, 1984/A2; see also previous references).

Asia, Australia and The Pacific

INDIA

In India several groups have been actively involved in array studies throughout the whole Peninsula. The greatest effort seems to be concentrated in the northern part, the collision zone between the Indian Plate and the Asian plate (Arora *et al.*, 1982/B1, 1987/B1; Lilley *et al.*, 1981/B1; Vozoff, 1984/B1). New details of the conducting structures have been reported, although improvements are still to be expected from subsequent modelling and the completion of the field studies (cf. Curve A, Figure 14).

In the southern part of the Peninsula recent effort seems to have been more on modelling studies than on new field work (Nityananda *et al.*, 1981/B1, 1983/B1; Ramaswamy *et al.*, 1985/B1; Srivastava *et al.*, 1982/B1, 1984/B1; Thakur *et al.*, 1981/B1).

SIBERIA

Studies in the tectonically active Baikal region provide an outstanding example of the benefit of using a statistical and averaging approach in regional studies (Berdi-

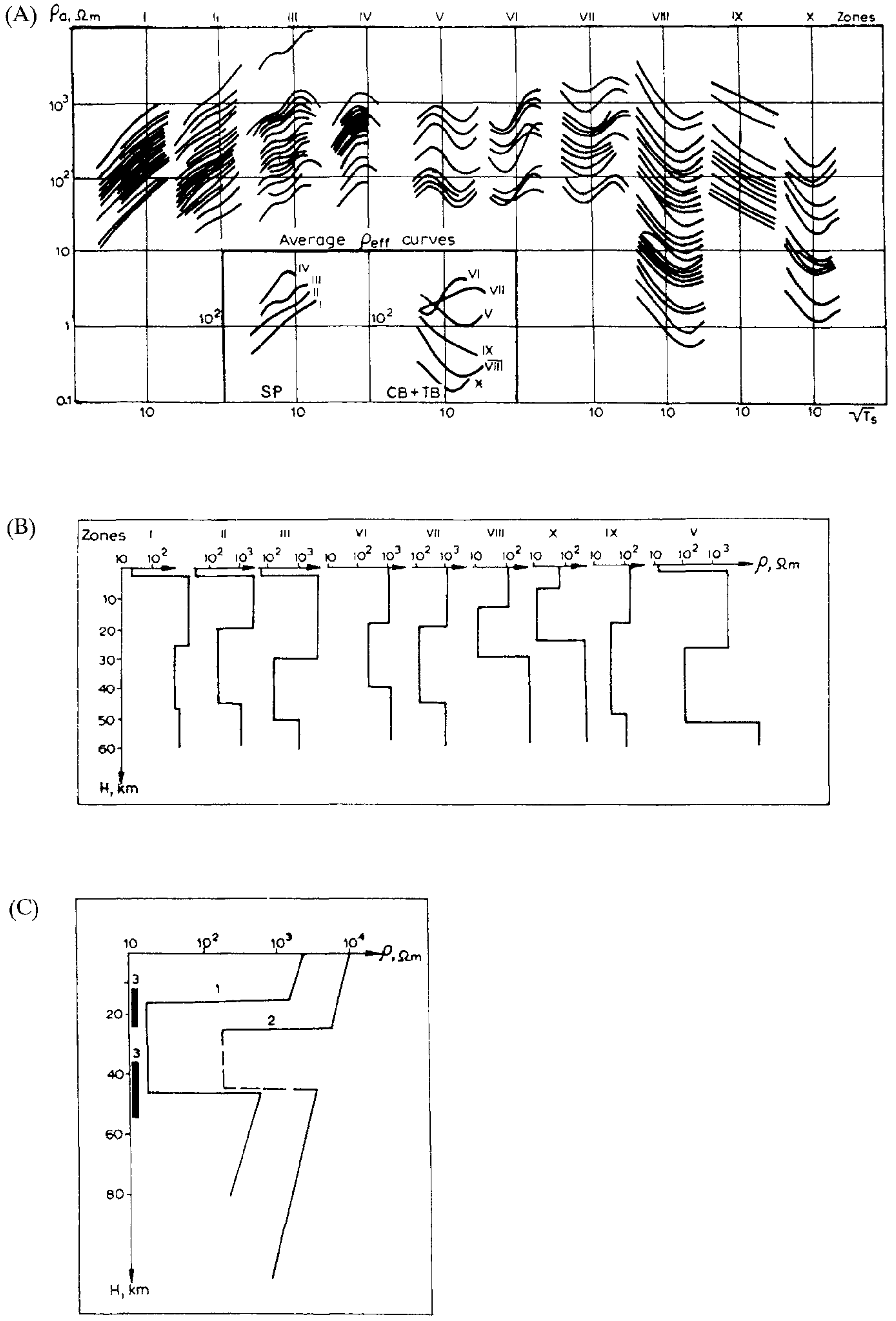


Fig. 6. Statistical regional magnetotelluric (MT) study of the Baikal region. (Berdichevsky *et al.*, 1980). (A) Division of the region into zones using the conformity of ρ_{eff} curves (ρ_{eff} is the geometric mean of ρ_{max} and ρ_{min}). (B) Inversion of the zone-averaged ρ_{eff} curves. (C) Summarized resistivity-versus-depth structures. 1. Trans-Baikal part (TB), 2. Siberian platform (SP), 3. Low velocity layer (LVL) according to DSS.

chevsky *et al.*, 1980/B2; Shilovsky, 1985/B2). Assuming, that the MTS curves are distorted only by galvanic effects (the term static shift seems to be preferred in the English literature) the effective apparent resistivity curves can easily be grouped according to their pattern. Group averages can then form the basis of the final interpretation (Figure 6).

For simplicity references from other Asian regions of the Soviet Union, Sakhalin (Nikiforov *et al.*, 1983/B2), the SW part of Asian U.S.S.R. (Zinger *et al.*, 1984/B2) and Kamchatka (Moroz, 1984/B2) have been included in this section. One of the more recent geoelectrical cross-sections has been constructed across the Amudarja syncline, passing close to the historic city of Samarkand (Berdichevsky *et al.*, 1986/B2).

China

MT activity has been initiated during the 80's in China and Tibet. Several interesting profiles and regional results are reported (cf. the references of Section B3). Reports on the North Margin of the North China Plain seem to contain both crustal and upper mantle conducting layers, although detailed 2D and 3D control still is lacking. From the first few MTS results from Tibet Van Ngoc *et al.* (1983/B3) reports the identification of conductive structures.

Japan and the Pacific

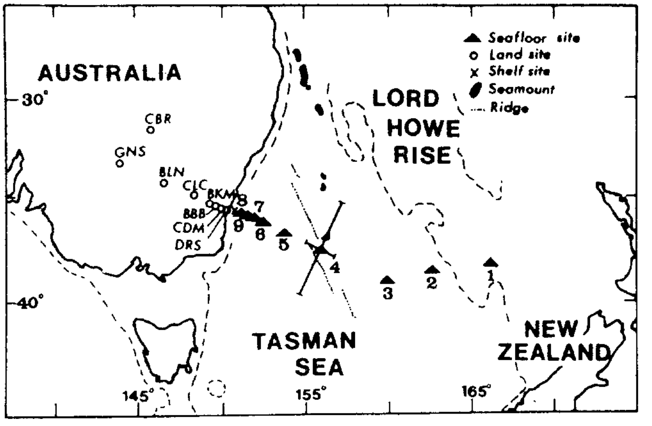
Due to geographical reasons, most results from these areas come from ocean measurements (for an exception, cf. the Honsuy study (Res Group Japan, 1983/B4). Since traditionally oceanic results are reported and reviewed separately at the Induction Workshops, only a list of references for this area is given here without further comments (cf. references in Section B4).

It may be appropriate to add a comment by Hermance (1983/E) concerning sea floor EM studies in general, although it was made in quite another context: 'the most interesting tectonic features of the sea floor are in areas, where all the complications of lateral resistivity variations exist and need to be accounted for'. He continues, that by necessity (equipment limitations and costs) sea-floor data increase more slowly than on land.

Australia

EM regional studies in Australia have continued to be actively pursued during the 80's (Lilley *et al.*, 1981a/B5, 1981b/B5, 1981c/B5; Lilley, 1982/B5, 1984/B5). 'Classical' array studies have been continued, details of earlier interpretations have been improved (Chamalaun 1985/B5) and some interesting new structures have been examined first by short profiles (Constable 1985a/B5; Filloux *et al.*, 1985/B5; Finlayson, 1982/B5; Ferguson *et al.*, 1985/B5; Ingham, 1985a/B5, 1985b/B5; White *et al.*, 1985/B5). Constable (1985b/B5) has summarized results from the

(A)



(B)

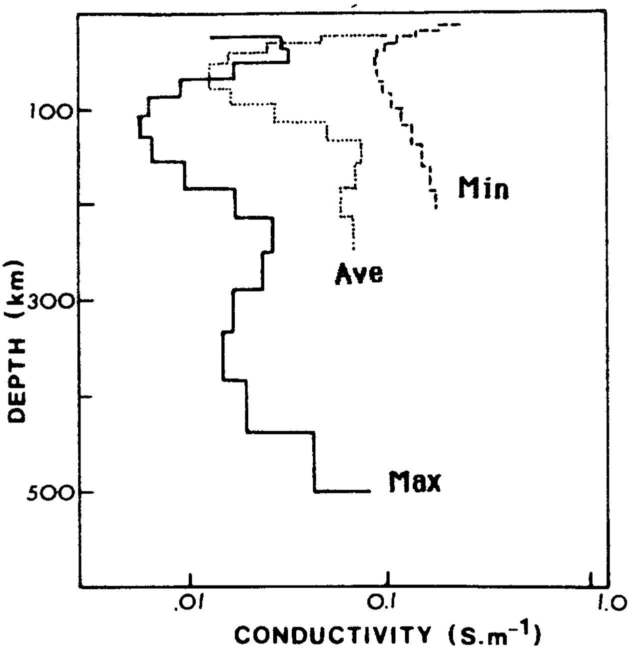


Fig. 7. First results of the Tasman sea floor MT project (Ferguson *et al.*, 1985/B5). (A) Recording sites. (B) Sample 1D inversions of data from site TP4.

Australian continent. Considerable efforts have been necessary to include properly the influence of the ocean on the results. Results from one of the newer profiles, involving sea bottom observations in the Tasman Sea, are seen in Figure 7.

Africa

The 'classical' studies of South Africa have recently been summarized by Gough

(1983/E) and de Beer *et al.* (1982/C). The studies were concentrated on the southern part of the continent, where the mobile Limpopo belt forms a distinctive conductive structure (cf. Figure 8, curve C). More recent regional activities have been concerned with profiles in the middle (Albuoy *et al.* 1982/C; Ogunade, 1983/C; Ritz, 1982a/C, 1982b/C, 1983a/C, 1983b/C, 1984a/C, 1984b/C) and northern (Menvielle *et al.*, 1982/C, 1985/C; Schwarz, 1986/C; Schwartz *et al.*, 1986/C) parts of the continent. Some of the results have been brought together in Figure 8. The Senegal craton seems to be free of a crustal conducting layer, which exists higher up in the crust on the West-African craton than in the mobile belt regions. The crustal conductor appears at comparable depths at the mobile belts both in the Southern and Central parts of the continent. Since the results are based on single profiles only, it seems too early to draw any summarizing conclusions as to the resistivities of the crust on the African continent as a whole.

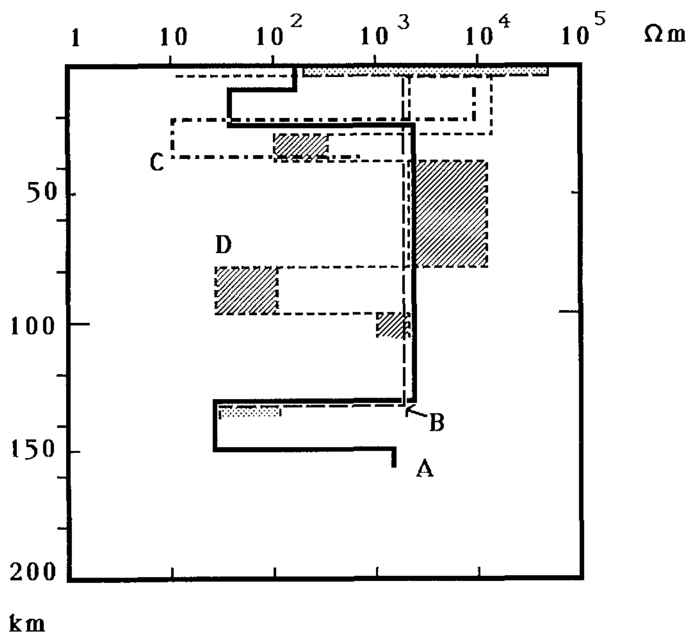


Fig. 8. Qualitative behaviour of resistivity-versus-depth in some African regions. (A) Senegal craton (Ritz, 1982b/C, 1984a, b/C); (B) West-African craton (Ritz, 1982a/C, 1983b/C); (C) The Limpopo mobile belt (Gough, 1983/E); (D) West-African mobile belt (Ritz, 1983a/C).

The American Continents and the Atlantic

Canada

The activity of Canadian regional electrical studies is on the same high level as in the U.S.A. The most interesting and intense regional effort is the EMSLAB Project in western Canada and U.S.A. and in the surrounding oceanic areas. Since these results will be reported and summarized elsewhere, only one preliminary result is mentioned here. The upper surface of the subducting Juan de Fuca Plate (cf. curve C of Figure 14) has been located accurately and in good accordance with seismic soundings below Vancouver Island (Gough 1986b/D1; Kurtz *et al.*, 1986/D1).

New details have been added to conductivity studies in 'classical' areas (e.g. Gough *et al.*, 1982/D1; Bingham *et al.*, 1985/D1; Jones *et al.*, 1986c/D1; Hutton *et al.*, 1987/D1), new areas have become the target of electrical regional studies (Jones *et al.*, 1986a/D1, 1986b/D1; Kurtz *et al.*, 1980/D1, 1986/D1; Prugger *et al.*, 1984/D1; Woods, 1985/D1; Woods *et al.*, 1986/D1). Gough (1983/E), Jones (1983/D1) and Kurtz *et al.* (1985/D1) have summarized the geoelectrical results for the Canadian Shield, the main trends being similar to those obtained on the Baltic Shield. The conductive structure of the lower crust, however, is claimed to be more uniform and continuous than is evident from the present Baltic Shield results. The depth range of the Lower Crustal Conductive Layer (LCCL) varies according to geographical position in relation to the Shield boundary and was used as a basis of a classification scheme by Jones (1981/E). Selective profiles from the Canadian Shield are represented in Figure 9, where the Kapuskasing zone is dipping 45° from the surface down to a depth of 10 km and contains at its bottom edge a thin, 10 Ω-m conducting layer. The crustal conductor below Ste Mathilde is much more conductive and the geoelectrical structure below Prince Edward Island has shallow depth conductors, which is assumed to be associated with genuine anisotropy of the rocks (Jones *et al.*, 1986/D1).

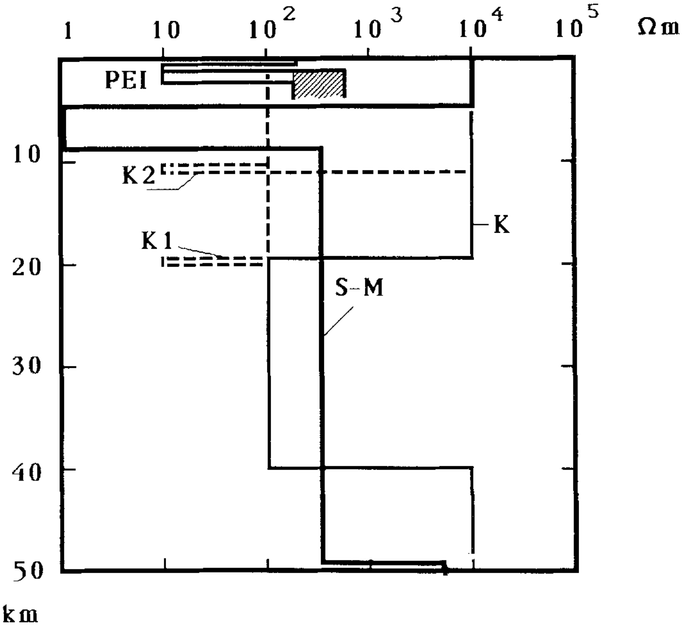


Fig. 9. Selected resistivity-versus-depth profiles for the Canadian Shield. K = the Kapuskasing zone, outside the 45° dipping zone; K1, K2 = two profiles above the 45° dipping zone (from Woods *et al.*, 1986/D1); PEI = Prince Edward Island (from Jones *et al.*, 1986b/D1); S-M = Ste Mathilde (from Kurtz *et al.*, 1980/D1).

ICELAND

Iceland is one of the most fascinating areas for EM crustal research because of its tectonic activity. Several groups have continued their electrical studies on Iceland (Hermance, 1981/D2; Beblo *et al.*, 1983/D2, 1985/D2; Hersir *et al.*, 1984/D2). The results include horizontal resistivity maps at different depths, obtained by DCS (Flovenz *et al.*, 1985/D2), and MTS profiles across the Reykjanes Ridge (Eysteinson *et al.*, 1985/D2; Thayer *et al.*, 1984/D2). The well conducting layers exist at shallower depth above the spreading ridge, whereas both the depth and the conductivity decrease as the distance on either side of the ridge increases (Figure 10, see also curve B in Figure 14).

In connection with interpretation of these regional results, attention has been paid to the mechanisms believed to explain the measured resistivity values. The results of Schmeling (1984a/D2, 1984b/D2, 1985/D2) shed new light upon the problem of the water and melt contents of magmatic rocks as well as on the role of the texture of the minerals grains for determining the resistivities of these rocks.

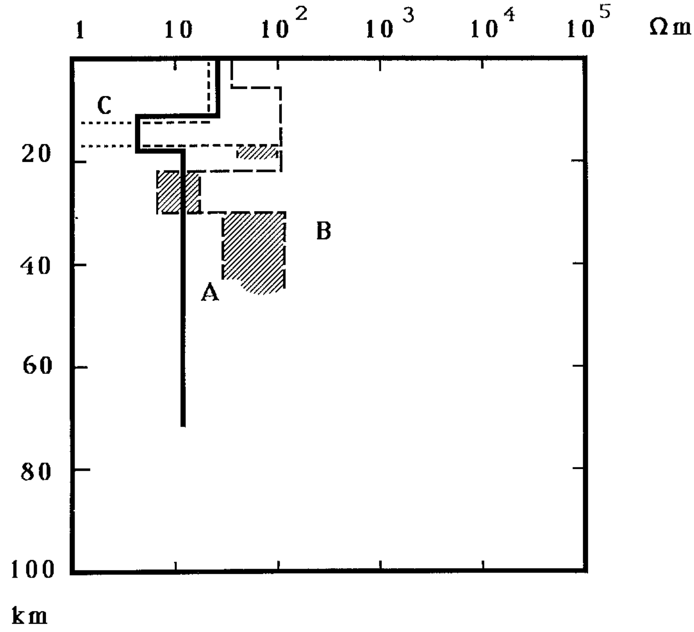
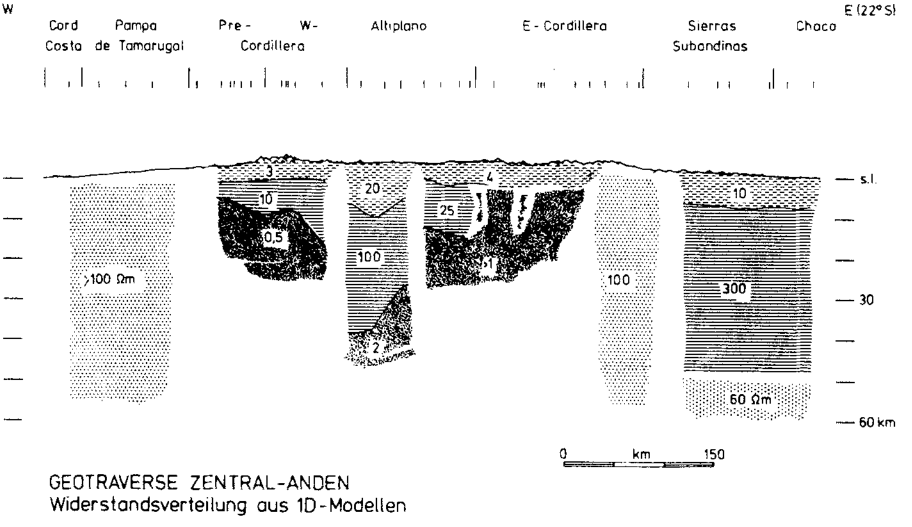


Fig. 10. Selected resistivity-versus-depth profiles for Iceland. (A) Above the Reykjanes rift (Beblo *et al.*, 1985/D2); (B) Far from the Reykjanes rift (Beblo *et al.*, 1985/D2); (C) "Generalized" curve (Eysteinsson *et al.*, 1985/D2).

SOUTH AMERICA

The main efforts of regional EM studies in South America have concentrated in two areas. In northern Chile and Bolivia the structure of the Nazca plate and its subducting part beneath the continent has been studied (Haak *et al.*, 1986/D38; Schwarz 1985/D3; Schwarz *et al.*, 1984/D3, 1985a/D3, 1985b/D3). An improved structural model of the Andean conductivity anomaly has been presented by Tarits *et al.* (1986/D3). The results of Schwarz suggest, that beneath the Altiplano a crustal well conducting structure is indicated above the subducting plate proper (cf. Figure 11). The conductivity increase is interpreted as caused by the upflow of hot

(A)



(B)

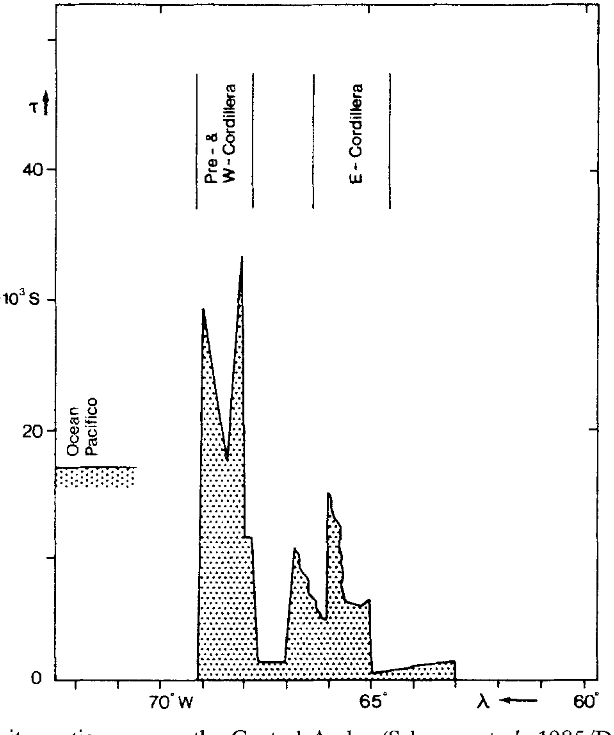


Fig. 11 Conductivity sections across the Central Andes (Schwarz *et al.*, 1985/D3). (A) Geoelectric cross-section obtained by Schmucker- inversion. (B) Integrated conductance for the uppermost 25 km.

material, but the penetration of the measurements is not great enough to indicate the conductivity of the subducting plate itself.

In the southern part of the South American continent EM activities have been reported mainly from Argentina (e.g. Baldis *et al.*, 1983/D3; Febrer *et al.*, 1980/D3; Gasco, 1982/D3; Vatin-Perignon *et al.*, 1985/D3). Many of the results are still at a preliminary interpretation stage.

U.S.A.

Very intensive activity has taken place over the whole North American continent during the last 10 y. The practical application to geothermal and hydrocarbon prospecting has increased the number of soundings tremendously. Keller has reported more than 10000 MTS points in the U.S.A. alone (Keller, 1986/D4, 1987/D4) and presented a concise summary of these results. Only one example of the summarized results is presented here (Figure 12). Keller notes, that although the regional conductivity structures are consistent, they are often at variance with seismic and gravity models from corresponding regions. This shows the need for new data and further detailed studies of existing EM data.

The case history of Jiracek *et al.* (1987/D4) reports on two parallel, regional MT profiles across the Rio Grande rift. The example is an excellent demonstration of the care needed in translating the inverted MTS results to a geological-tectonical model.

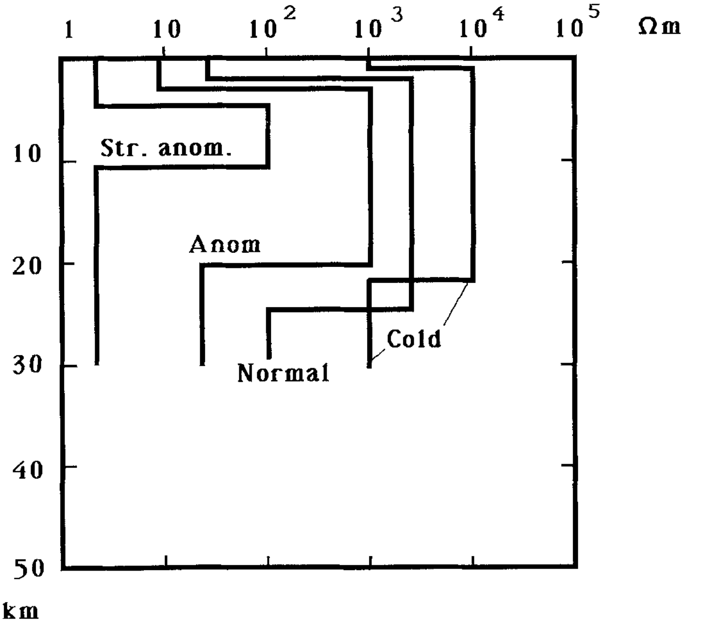


Fig. 12. Qualitative average resistivity-versus-depth profiles for the U.S.A. (from Keller, 1986/D4). *Strongly anomalous* and *anomalous* regions refer to areas in the extensional areas in Western US (Basin and Range province and the Rio Grande Rift); *cold* curve refers to the region around the Great Lakes, thus effectively to the Canadian Shield; *normal* values refer to all the other areas.

It is known, that magmatic activity exists below the centre part of both profiles. However, the conductivity structures beneath the profiles are remarkably different. Jiracek *et al.* (1987/D4) propose an explanation related to the fracturing of the bedrock above the magma chambers. A ductile rock cap is believed to exist below the N profile, trapping the magmatic liquids and forming a well conducting region clearly visible in MTS. In the S profile fluid filled cracks are thought to penetrate the ductile layer allowing the liquids to migrate upwards. No conductive trap is formed (Figure 13). The mountainous parts of the profiles are less conductive throughout.

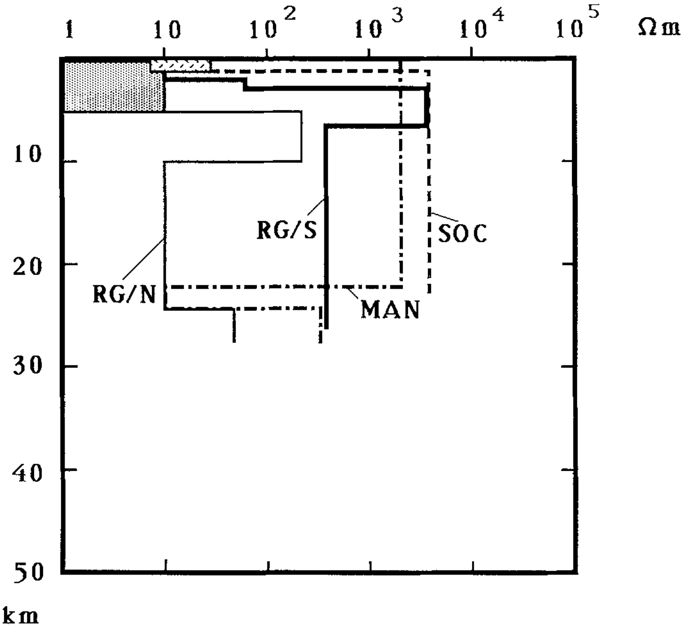


Fig. 13. Selected resistivity-versus-depth profiles for the Rio Grande Rift (from Jiracek *et al.*, 1987/D4). RG stands for locations on the rift itself, S for the Southern line and N for the Northern line; SOC = Socorro Mountains on the S-line, MAN = Manzano Mountains on the N-line.

General Comments

Finally Section E in the list of references mentions some papers of general interest (methodologically or otherwise) as well as some earlier reviews related to regional studies. Quite a few worthwhile books (Section F) have appeared during the 80's, starting with a reprint collection of classical MTS papers (Vozoff, 1986/F) to advanced theoretical monographs on interpretation (Berdichevsky *et al.* 1985/F) and basic theory (Kaufmann and Keller, 1983/F). It is now relatively easy for a research student to obtain a solid background of the methods and interpretation from such texts by himself, whereas only patient, accurate and careful field work forms the basis of improved understanding of the geoelectric structures of the Earth.

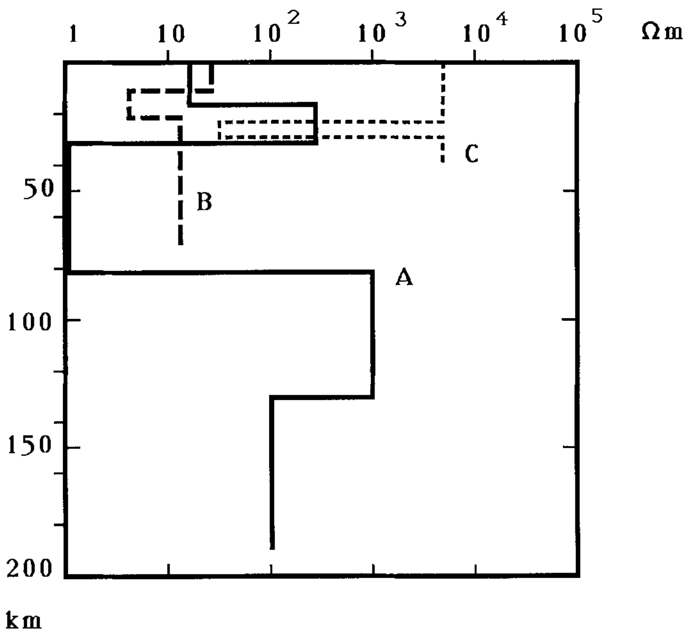


Fig. 14. Selected resistivity-versus-depth profiles for some tectonically active regions. (A) Subduction of the Indian plate under the Himalayas (from manuscript of Chamalaun *et al.*, 1986/B1); (B) The Reykjanes Ridge, Iceland (Beblo *et al.*, 1985/D2); (C) Subduction of the Juan de Fuca plate under the Vancouver Island (Kurtz *et al.*, 1986/D1).

The most outstanding feature when preparing this review has been the tremendous increase in the volume of regional or semi-regional geoelectrical studies all over the world. Since at the same time improvements in instrumentation and especially data processing have been very rapid, it is no longer possible for a single scientist to make a consice and reliable summary of all the results. There is certainly a great need for educated reviews and summaries by region. Hopefully the monograph on the findings of the recent activities on the Baltic Shield and the forthcoming results of the EMSLAB Project will form a good start in this direction.

Summary

A voluminous amount of regional EM studies have been reported during the first half of the 80's. The well-established concepts in instrumentation, data processing and interpretation techniques have made it easier for many new research groups to enter the field of geoelectrical studies. The use of methods earlier regarded only as research tools, have become feasible for practical application, such as prospecting for natural resources (minerals, oil, geothermics), and studies of sites for nuclear waste disposal. The applications often cover smaller areas, massifs, intrusions, fault zones, geothermal areas etc. with a dense network of stations.

Large simultaneous magnetometer arrays and dense profiling across interesting conductive structures using MT techniques are typical of regional studies today. The remote reference techniques, measuring all 5 field components during MT surveys and in-field data processing (at least for preliminary work) has become very popular. The use of active (or controlled) sources have gained in success, mainly in applications. For crustal studies large generators (e.g. MHD), transatlantic telephone cables and power lines have been in use. The lack of standardization of instrumentation and data processing techniques makes comparison over large areas difficult.

Electromagnetic data are increasingly often used together with other geophysical data during the interpretation stage, although joint inversion in the strict sense is still rare. Also discussion and detailed understanding of the tectonic and geological significance of conductive structures is continuously increasing. The possibility of correlating resistivity models with data from deep boreholes and studies in tectonically active regions like Iceland have been most useful. It has become more and more evident, that the accurate knowledge of the resistivity values of various bedrocks, minerals and even regions is usually less important than the overall qualitative behaviour, the order of magnitude and tectonic aspects of the resistivity structures. Statistical averaging techniques are especially valuable in regional MTS surveys, the more so, when sounding bandwidth and station spacing have been inadequate.

Projects, where EM studies are involved, exist on all continents, most of them being somehow related to the International Lithosphere Program. Results from the EGT and KAPG Geotraverse work are included in the examples of this review, whereas results from the largest EM effort, the EMSLAB project, will be discussed elsewhere.

The emphasis of regional EM studies in the 80's can be said to be twofold: Firstly improvement of 'classical' array studies have been made by means of reinterpretation, more accurate modelling and dense MT profiling across conductivity anomalies. Such aspects have dominated the regional studies in Australia, in the Carpathians, in India, in North Germany and in Scotland, but have also taken place in the U.S.A. and Canada.

Secondly new areas have been covered both by array studies and detailed structural mapping of various kinds. The greatest activity has been in the Baltic Shield, in Central and North Africa, in southeastern parts of Europe, in southwestern parts of Asia and in South America.

Recent improvements in numerical modelling techniques, although not covered in this review, are of greatest importance for regional studies. Great advances in thin-sheet modelling and promising new formal interpretation strategies have made it possible, that the majority of regional studies already include 2D models of the most important structural features. On the other hand, good, practical 3D modelling is still not at our disposal.

Active world-wide planning in the context of the ILP is currently aiming to start combined geophysical and geological Geotraverses called TRANSECTS. It is believed that EM studies can now make a valuable contribution to this programme and all induction scientist should be encouraged to participate in these multimethod geoscientific projects.

Acknowledgements

The following colleagues have kindly helped the author through discussions and by contributing with manuscripts and their latest results: A. Ádám, B. R. Arora, M. N. Berdichevsky, A. Berktold, T. Ernst, V. Haak, V. R. S. Hutton, M. R. Ingham, G. R. Jiracek, A. G. Jones, G. V. Keller, R. D. Kurtz, F. E. M. Lilley, E. R. Niblett, L. B. Pedersen, O. Praus, I. I. Rokityansky, P. VanNgoc, P. E. Wannamaker, L. L. Vanyan, D. Woods and M. S. Zhdanov. None of them should, however, be held responsible for any error, mis-interpretation or omission appearing in this paper.

The referees of this paper deserve the deepest thanks for the time and effort they had taken to improve both the content and the grammar of my text.

References

A. EUROPE

A1. Baltic Shield

Ádám, A., Kaikkonen, P., Hjelt, S. E., Pajunpää, K., Szarka, L., Verö, J., and Wallner, Á.: 1982, 'Magnetotelluric and Audiomagnetotelluric Measurements in Finland', *Tectonophysics* **90**, 77-90.

Ádám, A.: 1983, 'EM Induction Studies in Finland and General Crustal Physics', in Hjelt, S. E. (ed.), *The Development of the Geoelectric Model of the Baltic Shield*, Part 2. Proceedings of the 1st project symposium, Oulu, 15.—18.11.1983, Department of Geophysics, University of Oulu, Report, No. 8, pp. 1—16.

Dyakonova, A. G., Dyakonov, B. P., and Skachkov, P. P.: 1983, 'Electromagnetic Survey Results of the Murmansk Block of the Baltic Shield', in Hjelt, S. E. (ed.), *The Development of the Geoelectric Model of the Baltic Shield*, Part 2. Proceedings of the 1st project symposium, Oulu, 15.—18.11.1983, Department of Geophysics, University of Oulu, Report, No. 8, pp. 217—232.

Dyakonov, B. P., Krasnobayeva, A. G., Kachaev, Yu. P., Skachkov, P. P., Vishnev, V. S., and Astafyev, P. F.: 1982, 'Rezultati elektromagnitnogo zondirovaniya s MGD-generatorom na Murmanskom bloke (Results of electromagnetic sounding with the MHD-generator on the Murmansk block)', in *Glubinnie elektromagnitnie zondirovaniya s primeneniem impulsnikh MGD-generatorov*, Izd. Kolskogo Filiala AN SSSR, Apatiti, pp. 61—68.

Golod, M. I., Klabukov, B. N., Grishin, A. S., and Vasin, N. D.: 1983, in Hjelt, S. E. (ed.), *The Development of the Geoelectric Model of the Baltic Shield*, Part 2. Proceedings of the 1st project symposium, Oulu, 15.—18.11.1983, Department of Geophysics, University of Oulu, Report, No. 8, pp. 180—204.

Gorbunov, G. I., Belkov, I. P., Pavlovsky, V. I., Zhamaletdinov, A. A., Katseblin, P. L., Kachaev, Yu. P., Velikhov, Ye. P., Volkov, Yu. M., Dreizin, Yu. A., Kuksa, Yu. I, Zotov, A. V., Yevstigneyev, V. V., Lisin, A. S., Zhukov, B. P., Vengersky, V. V., and Babkov, Yu. P.: 1979, 'Glubinnoje elektromagnitnoje zondirovanije s MGD-generatorom na Kolskom poluostrove (Electromagnetic depth sounding with the MHD-generator on the Kola peninsula)', Dokl. Akad. Nauk SSSR 247, pp. 578—582.

Gorbunov, G. I., Belkov, I. P., Pavlovsky, V. I., Zhamaletdinov, A. A., Velikhov, Ye. P., Volkov, Yu. M., and Dreizin, Yu. A.: 1982, 'O kharaktere elektroprovodnosti zemnoi kori Kolskogo poluostrova po dannim zondirovaniya c MGD-generatorom (On the character of the electric conductivity of the Earth's crust on the Kola peninsula obtained from soundings with the MHD-generator)', Geomagnetic Researches No 28, 'Radio i svjaz', Moskva, pp. 85—93.

Heikka, J.: 1983, 'The MHD source and preliminary results of 5-component registrations in Northern Finland', in Hjelt S. E. (ed.), *The Development of the Geoelectric model of the Baltic Shield*, Part 2. Proceedings of the 1st project symposium, Oulu, 15.—18.11.1983, Department of Geophysics, University of Oulu, Report, No. 8, pp. 263—275.

Heikka, J., Zhamaletdinov, A. A., Hjelt, S. E., Demidova, T. A., and Velikhov, Ye. P.: 1984, 'Preliminary Results of MHD Test Registrations in Northern Finland', *J. Geophys.* **55**, 199—202.

Hjelt, S. E.: 1984, 'Deep Electromagnetic Studies of the Baltic Shield', *J. Geophys.* **55**, 144—152.

Hjelt, S. E., 1987, 'Aspects of the Geoelectric Models of the Baltic Shield', *Precambr. Res.* **35**, 181—194.

Hjelt, S. E., Kaikkonen, P., Pajunpää, K., Korja, T., and Heikka, J.: 1986, 'Electromagnetic Studies of the Baltic Shield in Finland', *Ann. Geophysicae* **4B**: 2, 131—138.

Jones, A. G., 1981, 'Geomagnetic Induction Studies in Scandinavia. — II. Geomagnetic Depth Sounding, Induction Vectors and Coast Effect', *J. Geophys.* **50**, 23—36.

Jones, A. G.: 1982a, 'Observations of the Electric Asthenosphere Beneath Scandinavia', *Tectonophysics* **90**, 37—55.

Jones, A. G.: 1982b, 'On the Electrical Crust-Mantle Structure in Fennoscandia: No Moho and the Asthenosphere Revealed?', *Geophys. J. R. Astron. Soc.* **68**, 371—388.

Jones, A. G.: 1983, 'The Electrical Structure of the Lithosphere and Asthenosphere Beneath the Fennoscandian Shield', *J. Geomag. Geoelectr.* **35**, 811—827.

Jones, A. G., Olafsdottir B., and Tiikkainen, J.: 1983, 'Geomagnetic Induction Studies in Scandinavia. — III. Magnetotelluric Observations', *J. Geophys.* **54**, 35—50.

Kaikkonen, P.: 1983, 'Some Results of the Thin Sheet Approximation for the Baltic Shield', in Hjelt, S. E. (ed.), *The Development of the Geoelectric Model of the Baltic Shield*, Part 2. Proceedings of the 1st project symposium, Oulu, 15.—18.11.1983, Department of Geophysics, University of Oulu, Report, No. 8, pp. 96—97.

Kaikkonen, P. and Pajunpää, K.: 1984, 'Audiomagnetotelluric Measurements Across the Lake Ladoga-Bothnian Bay Zone in Central Finland', *Geophys. J. R. Astr. Soc.* **78**, 439—452.

Kaikkonen, P., Vanyan, L. L., Hjelt, S. E., Shilovsky, A. P., Pajunpää, K., and Shilovsky, P. P.: 1983, 'A Preliminary Geoelectrical Model of the Karelian Megablock of the Baltic Shield', *Phys. Earth Planet. Inter.* **32**, 301—305.

Korja, T.: 1983, 'On Magnetotelluric Measurements in Finland', in Hjelt, S. E. (ed.), in *The Development of the Geoelectric Model of the Baltic Shield*, Part 2. Proceedings of the 1st project symposium, Oulu, 15.—18.11.1983, Department of Geophysics, University of Oulu, Report, No. 8, pp. 276—296.

Korja, T.: 1986a, 'Electromagnetic Studies on the POLAR Profile: Preliminary Results', Department of Geophysics, University of Oulu, Report No. 12, 47 pp.

Korja, T.: 1986b, 'On the Geoelectrical Structure of the Crust and Upper Mantle in Finland', (in Finnish) Unpubl. Lis. Thesis, Univ. of Oulu, Dept of Geophysics.

Korja, T., Zhang, P., and Pajunpää, K.: 1986, 'Magnetovariational and Magnetotelluric Studies of the Oulu Anomaly on the Baltic Shield in Finland', *J. Geophys.* **59**, 32—41.

Krasnobaeva, A. G., Dyakonov, B. P., Astafyev, P. F., Batalova, O. V., Vishnev, V. S., Gavrilova, I. E., Zhuravlyova, B., and Kirillov, S. K.: 1981, 'Structure of the Northeastern Part of the Baltic Shield from Magnetotelluric Data', Physics of the Earth, Bull AN SSSR, No. 6, 65—73.

Küppers, F. and Post, H.: 1981, 'A Second Generation Gough- Reitzel Magnetometer', *J. Geomag. Geoelectr.* **33**, 225—237.

Lange, K.: 1979, 'Induktionseffekte in Nordskandinavien — untersucht am Beispiel zweier ostwärts fliessender polarer Elektrojets', Dipl. thesis, Universität zu Münster, 160 pp.

Lisin, A. S., Medvedev, F. A., and Yevsigneyev, V. V.: 1982, 'Fizicheskoje modelirovanije elektrodinamiki istochnika polja, pitajemogo MGD-generatorom' (Physical modeling of the electrodynamic source field fed by the MHD generator), in *Glubinnie elektromagnitnie zondirovaniya s primeneniem impulsnikh MGD-generatorov*, Izd. Kolskogo Filiala AN SSSR, Apatiti, pp. 129—135.

Osipova, I. L., Hjelt, S.-E., and Vanyan, L. L.: 1987, 'Source Field Problems in Northern Parts of the Baltic Shield', *Phys. Earth Planet. Inter.* (in print).

Pajunpää, K.: 1983, 'Magnetometer Array Studies in Central and South-Eastern Finland', in Hjelt, S. E., (ed.), *The Development of the Geoelectric Model of the Baltic Shield*, Part 2. Proceedings of the 1st project symposium, Oulu, 15.-18.11.1983, Department of Geophysics, University of Oulu, Report, No. 8, pp. 245—262.

Pajunpää, K.: 1984, 'Magnetometer Array Studies in Finland- Determination of Single Station Transfer Functions', *J. Geophys.* **55**, 153—160.

Pajunpää, K.: 1986, 'Magnetometer Array Studies in South-Eastern Finland on the Baltic Shield', *J. Geophys.* **59**, 23—31.

Pajunpää, K., Heikka J., and Korja T.: 1983, 'Magnetometer Array Studies in Finland', *J. Geomag. Geoelectr.* **35**, 543—553.

Rasmussen, T. M.: 1987, 'Magnetotelluric Investigations of the Baltic Shield in Sweden. Techniques and Geophysical Implications'. Diss. Univ. Uppsla. Acta Univ. Ups.

Rasmussen, T., Zhang, P., and Pedersen, L. B.: 1983, 'Preliminary Results from Magnetotelluric Measurements along the Fennolora Profile', in Hjelt S. E. (ed.), *The Development of the Geoelectric Model of the Baltic Shield*, Part 2. Proceedings of the 1st project symposium, Oulu, 15.—18.11.1983, Department of Geophyscis, University of Oulu, Report, No. 8, pp. 307—327.

Rasmussen, T. M., Roberts, R. G., and Pedersen, L. B.: 1987, 'Magnetotellurics along the Fennoscandian Long Range Profile', *Geoph. J. R. Astron. Soc.* **89**, 799—820.

Richmond, A. D., and Baumjohann, W.: 1983, 'Three-Dimensional Analysis of Magnetometer Array Data', *J. Geophys.* **54**, 138—156.

Roberts, R. G., Zhang, and Pedersen, L. B.: 1983, 'Remote Reference Magnetotellurics Across a Mylonite Shear Zone in Southern Sweden: A Preliminary Report', in Hjelt S. E. (ed.), *The Development of the Geoelectric Model of the Baltic Shield,* Part 2. Proceedings of the 1st project symposium, Oulu, 15.—18.11.1983, Department of Geophysics, University of Oulu, Report, No. 8, pp. 328—339.

Rokityansky, I. I.: 1983, 'Geoelectromagnetic Studies of the Baltic and Ukrainian Shield: Review of Some Results', in Hjelt S. E. (ed.), *The Development of the Geoelectric Model of the Baltic Shield*, Part 2. Proceedings of the 1st project symposium, Oulu, 15.—18.11.1983, Department of Geophysics, University of Oulu, Report, No. 8, pp. 110—150.

Rokityansky, I. I., Kulik S. N., and Rokityanskaya, D. A.: 1981, 'The Ladoga Electric Conductivity Anomaly (In Russian)', *J. Geophysics, The Ukr. Acad. Sci.*, **3**, No 2, 97—100.

Vagin, S. A., Vardanyants, I. L., Kovtun, A. A., Kokvina, E. L., Moisejev, O. N., Saveljev, A. A., and Uspenskii, N. I.: 1985, 'Magnetotelluricheskie zondirovanija v intervale periodov 10^{-3}—10^4 s na Murmanskom bloke Kolskogo poluostrova i v Chentralnoi Karelii (Magnetotelluric sounding in the period interval 10^{-3}—10^4 s on the Murmansk block of the Kola peninsula and in Central Karelia)', *Physics of the Earth, Bull. AN SSSR* **21**: 5, 48—56.

Vanyan, L. L., Demidova, T. A., Yegorov, I. V., and Palshin, N. A.: 1986, 'On the Deep Dipole DC Soundings of the Baltic Shield (in Russian)', *Physics of the Earth, Bull. AN SSSR* **22**: 8, 63—71.

Velikhov, Ye. P., Zhukov, B. P., Gorbunov, G. I., Volkov, Yu. M., Zhamaletdinov, A. A., Lisin, A. S., Tokarev, A. D., Kuksa, Yu. I., Kirillov, S. K., and Poltanov, A. Ye.: 1983, 'The Deep Electric Section of Basement by Results of MHD-Sounding on the Kola Peninsula', in Hjelt S. E. (ed.), *The Development of the Geoelectric model of the Baltic Shield*, Part 2. Proceedings of the 1st project symposium, Oulu, 15.—18.11.1983, Department of Geophysics, University of Oulu, Report, No. 8, pp. 205—216.

Velikhov, Ye. P., Gorbunov, G. I., Volkov, Yu. M., Zhukov, B. P., Vanyan, L. L., Demidova, T. A., Zhamaletdinov, A. A., Hjelt, S. E., and Heikka, J.: 1983, 'First Soviet-Finnish Experiment to Registrate Signals of the MHD-Generator (in Russian)', *Dokl. Akad. Nauk SSSR* **271**, 324—327.

Velikhov, Ye. P., Zhamaletdinov, A. A., Belkov, I. P., Gorbunov, G. I., Hjelt, S. E., Lisin, A. S., Vanyan, L. L., Zhdanov, M. S., Demidova, T. A., Korja, T., Kirillov, S. K., Kuksa, Yu. I., Poltanov, A. Ye., Tokarev, A. D., and Yevstigneyev, V. V.: 1986, 'Electromagnetic Studies on the Kola Peninsula and in Northern Finland by Means of a Powerful Controlled Source', *J. Geodynamics* **5**, 237—256.

Velikhov, Ye. P., Zhamaletdinov, A. A., and Zhdanov, M. S.: 1984, 'Eksperiment "Khibiny" (in Russian)', *Zemlya i vselennaya,* No **5**, 12—19.

Velikhov, Ye. P., Zhdanov, M. S., and Frenkel, M. A.: 1984, 'Interpretation of MHD Sounding on the Kola Peninsula Using the New Method of Electromagnetic Migration (in Russian)', *Dokl. Akad. Nauk SSSR* **276**, 329—334.

Velikhov, Ye. P., Zhdanov, M. S., and Frenkel, M. A.: 1987, 'Interpretation of MHD-Sounding Data from

from the Kola Peninsula by the Electromagnetic Migration Method', *Phys. Earth Planet. Inter.* **45**, 149—160.

Zhamaletdinov, A. A.: 1982, 'Normal Electric Cross-section of the Crystalline Basement and its Geothermal Interpretation from MHD-soundings on the Kola peninsula' (in Russian), in *Glubinnie elektromagnitnie zondirovaniya s primeneniem impulsnikh MGD-generatorov*, Izd. Kolskogo Filiala AN SSSR, Apatiti, pp. 35—46.

Zhamaletdinov, A.A.: 1984, 'Electrical Depth Models for Shields and Ancient Platforms' (in Russian), in *Korovije anomalii elektroprovodnosti*, Nauka, Leningrad, pp. 21—27.

Zhang P., Rasmussen T., Korja T., Koivukoski K., Hjelt S. E., and Pedersen L. B.: 1983, 'Preliminary Results from a MT Study of a Conductive Zone in Finland', in Hjelt, S. E. (ed.), *The Development of the Geoelectric Model of the Baltic Shield*, Part 2. Proceedings of the 1st project symposium, Oulu, 15.—18.11.1983, Department of Geophysics, University of Oulu, Report, No. 8, pp. 296—306.

Zhang, P., Rasmussen, T. M., and Pedersen, L. B.: 1987, 'Electrical Resistivity Structure of the Siljan Impact Region', *J. Geophys. Res.* (subm.)

Zhdanov, M. S., and Frenkel, M. A.: 1983, 'The Solution of Inverse Problem on the Basis of the Analytical Continuation of Transient Electromagnetic Field in the Reverse Time. *J. Geomag. Geoelectr.* **35**, 745—776.

The Development of the Geoelectric Model of the Baltic Shield, Part 1. (Hjelt, S. E., Vanyan, L. L. eds.). Department of Geophysics, University of Oulu, Report, No. 7.

The Development of the Geoelectric Model of the Baltic Shield, Part 2, Proceedings of the 1st project symposium, Oulu, 15.—18.11.1983 (Hjelt, S E., ed.). Department of Geophysics, University of Oulu, Report, No. 8.

A2. The Carpathian Region

Abramova, L. M., Gaidash, S. P., Kharitonov, A. L. Korotaev, S. M. Shabeliansky, S. V., and Trofimov, I. L.: 1984, 'Marine Electromagnetic Measurements on the Bulgarian Continental Shelf of the Black See (Preliminary report), *Acta Geod. Geophys. et Montan. Hung.* **19**, 5—13.

Abramova, L. M., Golubev, N. G., Karpman, I. V., Kondraseva, N. V., and Sneyer, V. S.: 1984, 'Geoelectric Inhomogeneities in the Eastern Part of the International Geotraverse V', *Acta Geod. Geophys. et Montan. Hung.* **19**, 15—18.

Ádám, A.: 1981, 'Statistische Zusammenhänge zwischen elektrischen Leitfähigkeitsverteilung und Bruchtektonik in Transdanubien (West-Hungarn)', *Acta Geod. Geophys. et Montan. Hung.* **16**, 97—113.

Ádám, A.:1984, 'Fractures as Conducting Dykes and Corresponding Two-dimensional Models', *Geophys. Prospecting* **32**, 543—553.

Ádám, A.: 1985a, 'Electromagnetic Induction Studies at the Geodetic and Geophysical Research Institute (Sopron)', in Special Issue of the Geodetic and Geophysical Research Institute of the Hungarian Acad. of Sciences in Honour of Prof. Tárczy-Hornoch, A., pp. 126—141.

Ádám, A.: 1985b, 'Electric Conductivity Increase in the Earth's Crust in Transdanubia (W-Hungary)'. A Status Report, *Acta Geod. Geophys. et Montan. Hung.* **20**, 173—182.

Ádám, A., Duma, G., Gutdeutsch, R., Verö, J., and Wallner. Á.: 1984a, 'Periadriatic Lineament in the Alps by Magnetotellurics (in Hungarian)', *Magyar Geofizika* **25**, 136—150.

Ádám, A., Duma, G., Gutdeutsch, R., Verö, J., and Wallner, Á.: 1986a, 'Periadriatic Lineament in the Alps Studied by Magnetotellurics', *J. Geophys.* **59**, 103—111.

Ádám, A., Märcz, F., Verö, J., Wallner, Á., Duma, G., and Gutdeutsch, R.: 1981, 'Magnetotelluric Sounding in the Transition Zone between the Eastern Alps and Pannonian Basin', *J. Geophys.* **50**, 37—44.

Ádám, A., and Pospisil, L.: 1984b, 'Crustal Conductivity Anomalies in the Carpathian Region', *Acta Geod. Geophys. et Montan. Hung.* **19**, 19—34.

Ádam, A., Szarka, L., and Varga, M.: 1983, 'Physical and Mathematical Modeling of Crustal Conductivity Anomalies in the Pannonian Basin', *Acta Geod. Geophys. et Montan. Hung.* **18**, 467—488.

Ádám, A., Szarka, L., Verö, J., and Wallner, Á.: 1986b, 'Magnetotellurics (MT) in Mountains — Noise, Topographic and Crustal Inhomogeneity Effects', *Phys. Earth Planet. Inter.* **42**, 165—177.

Ádám, A., Vanyan, L. L., Varlamov, D. A., Yegorov, I. V., and Shilovski, A. P.: 1983c, 'Deep Electric Conductivity of the Pannonian (Transdanubian) Basin', *Phys. Solid Earth, Bull AN SSSR* **20**: 6, 100—102. (Engl. transl. pp. 477—479).

Bromek, A.: 1982, 'Modelling of Electromagnetic Induction with Finite Element Method for Two-dimensional Structures. Comparison of Results Obtained with Finite Element and Finite-differences methods for the Carpathian Model', *Acta Geophys. Pol.* **30**, 153—166.

Červ, V., Pek, J., and Praus, O.: 1984, 'Models of Geoelectrical Anomalies in Czechoslovakia', *J. Geophys.* **55**, 161—168.

Jankowski, J., Szymanski, A., Tarlowski, Z., Pěč, K., Pěčová, J., Petr. V., Praus, O., and Červ, V.: 1980, 'Electromagnetic Induction in the Carpathian Field Experiments and Modelling (abstr. only)', Publ. Inst. Geophys., Pol. Acad. Sci. A-8, 127—128.

Jankowski, J., Tarlowski, Z., Praus, O., Pěčová, J., and Petr, V.: 1985, 'The Results of Deep Geomagnetic Soundings in the West Carpathians, *Geoph. J. R. Astron. Soc.* **80**, 561—574.

Pěč, K., Pěčová, J., and Praus, O.: 1980, 'Inverse Magnetotelluric Problem for Sounding Curves from Czechoslovak localities', *J. Geomag. Geoelctr.* **32**, Suppl. I, 159—170.

Pěčová, J.: 1982, 'Determination of the Depth of a Conductivity Anomaly by Separating the Geomagnetic Variation Field into its Internal and External Part', *Travaux Géophysiques* **XXX**, 179—197.

Petr, V., Pěčová, J., and Praus, O.: 1984, 'Induction Vector Estimates in the Bohemian Massif and in the Transition Zone to the Carpathians', *Studia Geoph. et Geod.* **28**, 172—177.

Petr, V., Pěčová, J., and Praus, O.: 1985, 'Anomaly of Geomagnetic Variations in the Southeastern Margin of the Bohemian Massif', *Studia Geoph. et Geod.* **29**, 169—190.

Petr, V., Pěčová, J., Praus, O., and Pec, K.: 1987, 'Anomalous Induction Zone near the Eastern Margin of the Bohemian Massif', *Phys. Earth Planet. Inter.* **45**, 161—169.

Pichá, B., Červ, V., and Pek, J.: 1984, 'Magnetotelluric Inversion along the Osvetimany-Brezova pod Bradlom Profile', *Studia Geoph. et Geod.* **28**, 101—112.

Praus, O., Červ, V., and Pek, J.: 1982, 'Geomagnetic Induction Vectors and their 2D Inversion', *Contr. Geoph. Inst. Slov. Acad. Sci.* **13**, 55—63.

Praus, O., Pěčová, J., Petr, V., Pěč, K., Hvoždara, M., Červ, V., Pek, J., and Laštovičková, M.: 1981, 'Electromagnetic Induction and Electrical Conductivity of the Earth's Body', in A. Zatopek (ed.), *Geophysical Syntheses in Szechoslovakia.* VEDA Publ. House, Slovak Acad. Sci., Bratislava, pp. 297.

Rokityansky, I. I., and Yudin, M. N.: 1984, 'Modeling of the Electromagnetic Field in the Carpathian Region', *Acta Geod. Geophys. et Montan. Hung.* **19**, 139—144.

Stănică, M., and Stănică, D.: 1981, 'The Use of Natural Electromagnetic Field of the Earth for the Construction of a Structural Model of the East Carpathian Arch (in Romanian)', *St. Cerc. Geol. Geofiz. Geogr., Geofizika* **19**, 41—51.

Stănică, M., and Stănică, D.: 1984, 'Crust and Upper Mantle Investigation by Magnetotelluric Soundings in Romania', *Acta Geod. Geophys. et Montan. Hung.* **19**, 147—152.

Zhdanov, M. S., Varentsov, I. M., and Bilinsky, A. I.: 1983, 'Formalized 2D Interpretation of the Induction Anomaly in the Soviet Carpathians', *Acta Geod. Geophys. et Montan. Hung.* **18**, 165—171.

Zhdanov, M. S., Berdichevsky, M. N., Shneer, V. S., Fainberg, E. B., Bobrov, V. N., Bilinsky, A. I., Kulik, S. N., and Logvinov, I. M.: 1984, 'Synchronous Magnetotelluric Measurements along a Profile in the Soviet Carpathian Region', *Acta Geod. Geophys. et Montan. Hung.* **19**, 185—188.

Zhdanov, M. S., Golubev, N. G., Varentsov, I. M., Abramova, L. M., Shneer, V. S., Berdichevsky, M. N., Zhdanova, O. N., Gordienko, V. V., Kulik, S. N., and Bilinsky, A. I.: 1986, '2-D Model Fitting of a Geomagnetic Anomaly in the Soviet Carpathians', *Ann. Geophysicae* **4**, B3, 335—342.

A3. North Germany

Bahr, K.: 1983, 'Joint Interpretation of Magnetotelluric and Geomagnetic Data and Local Telluric Distortions', *J. Geomag. Geoelectr.* **35**, 555—566.

Bejarano-Gerke, G., and Jödicke, H.: 1984, 'Magnetotellurik in Münsterland und am Niederrhein', in *Protokoll über das 10. Kolloquium "Elektromagnetische Tiefenforschung"*, Graftahl/Oberbayern, 19.—23. März 1984, pp. 93—102.

Berktold, A., and •.egner, P.: 1984, 'Zur Vertikalkomponente der erdmagnetischen Variationen in Bereich der variskischen Grossstrukturen Mitteleuropas', in *Protokoll über das 10. Kolloquium "Elektromagnetische Tiefenforschung"*, Graftahl/Oberbayern, 19.—23. März 1984, pp. 45—46.

Büchter, C.: 1984, 'Vergleichende Untersuchung magnetotellurischer Tiefensondierungen und elektrischer Bohrlochmessungen an der Tiefbohrung Münsterland 1', in *Protokoll über das 10. Kollo-*

quium "Elektromagnetische Tiefenforschung", Graftahl/Oberbayern, 19.—23. März 1984, pp. 79—92.

Dittus, H., Teufel, U., and Berktold, A.: 1984, 'Messungen mit den Methoden der Audio-Magnetotellurik, Magnetotellurik und Erdmagnetischen Tiefensondierung längs eines NS-Profiles über den Alpennordland vom Waginger See bis zur Reiteralpe', in *Protokoll über das 10. Kolloquium "Elektromagnetische Tiefenforschung"*, Graftahl/Oberbayern, 19.—23. März 1984, pp. 47—58.

Jödicke, H.: 1984, 'Zur Deutung magnetotellurisch nachgewiesener guter Leiter im teiferen Untergrund Nordwestdeutschlands', in *Protokoll über das 10. Kolloquium "Elektromagnetische Tiefenforschung"*, Graftahl/Oberbayern, 19.—23 März 1984, pp. 331—334.

Jödicke, H.: 1985, 'Good Conducting Layers at Great Depth in the NW-German Sedimentary Basin'. Paper prestented at EUG III, April 1—4 1985, Strasbourg, France, *Terra Cognita* **5**, 300 (abstract only).

Jödicke, H., and Grinat, M.: 1985, 'Magnetotelluric Measurements at the SE Flank of the Stavelot-Venn Anticline using the Remote Reference Technique', N.Jb. Geol. Paläont. Abh. 171: 1—3, 425—440.

Jödicke, H., Keil, M., Blohm, E-K., and Wagenitz, V.: 1982, 'Magnetotellurische und geoelektrische Untersuchungen im Gebiet der magnetischen Anomalie von Soest-Erwitte und ihre Bedeutung für die stratigraphische Einstufung des prädevonischen Konduktors im Untergrund Nordwestdeutschlands', *Fortschr. Geol. Rheinl. u. Westf.* **30**, 363—403.

Jödicke, H., Untiedt, J., Olgemann, W., Schulte, L., und Wagenitz, V.: 1983, 'Electrical Conductivity Structure of the Crust and Upper Mantle beneath the Rhenish Massif', in Fuchs, K. et al. (eds), *Plateau uplift*, Springer-Verlag, pp. 288—302.

Regner, P., and Berktold, A.: 1984, 'Distribution of Electrical Conductivity near the Transition Zone Moldanubikum/Saxothuringikum'. Paper presented at Origin and evolution of the Earth, Moon and their planetary neighbours, Feb 1984, Mainz, FRG, *Terra Cognita* **4**, 110 (abstract only).

Wagenitz, V.: 1982, 'Tellurisch-magnetotellurische Untersuchungen zur Bestimmung der elektrischen Leitfähigkeit in der oberen Kruste im Bereich der Anomalie von Bramsche und des Niedersächsischen Tektogens', Diss. Univ. Münster, 138 pp.

A4. British Isles

Banks, R. J., and Beamisch, D.: 1984, 'Local and Regional Induction in the British Isles', *Geoph. J. R. Astron. Soc.* **79**, 539—553.

Banks, R. J., Beamish, D., and Geake, M. J.: 1983, 'Magnetic Variation Anomalies in Northern England and Southern Scotland', *Nature* **303**, 516—518.

Beamish, D.: 1985, 'The Frequency Characteristics of Anomalous Vertical Fields Observed in the British Isles', *J. Geophysics* **57**, 207—216.

Beamish, D.: 1986, 'Deep Crustal Geoelectric Structure Beneath the Northumberland Basin', *Geoph. J. R. Astron. Soc.* **84**, 619—640.

Beamish, D., and Banks, R. J.: 1983, 'Geomagnetic Variation Anomalies in Northern England: Processing and Presentation of Data from a Non-simultaneous Array', *Geoph. J. R. Astron. Soc.* **75**, 513—519.

Beamish, D., and Smythe, D. K.: 1986, 'Geophysical Images of the Deep Crust: The Iapetus Suture', *J. Geol. Soc.* London (submitted).

Hutton, V. R. S., Mbipom, E. W., and Hill, E. R. G.: 1984, 'Geoelectromagnetic Studies in the Region of the North Atlantic Shield Fragment in Scotland', in Hjelt, S. E (ed.), *The Development of the Geoelectric Model of the Baltic Shield*, Part 2. Proceedings of the 1st project symposium, Oulu, 15.—18.11.1983, Department of Geophysics, University of Oulu, Report, No. 8, pp. 151—165.

Hutton, V. R. S., Ingham, M. R., and Mbipom, E. W.: 1980, 'An Electrical Model of the Crust and Upper Mantle in Scotland', *Nature* **287**, 30—33.

Hutton, V. R. S., and Jones, A. G.: 1980, 'Magnetovariational and Magnetotelluric Investigations in S. Scotland', *Adv. Earth Planet. Sci.* **9**, 141—150.

Hutton, V. R. S., Dawes, G., Ingham, M R., Kirkwood, S., Mbipom, E. W., and Sik, J.: 1981, 'Recent Studies of Time Variations of Natural Electromagnetic Fields in Scotland', *Phys. Earth Planet. Inter.* **24**, 66—87.

Ingham, M. R., and Hutton, V. R. S.: 1982a: 'Crustal and Upper Mantle Electrical Conductivity Structure in Southern Scotland', *Geoph. J. R. Astron. Soc.* **69**, 579—594.

Ingham, M. R., and Hutton, V. R. S.: 1982b, 'The Interpretation and Tectonic Implications of the Geoelectric Structure of Southern Scotland', *Geoph. J. R. Astron. Soc.* **69**, 595—606.
Kirkwood, S., Hutton, V. R. S., and Sik, J.: 1981, 'A Geomagnetic Study of the Great Glen Fault', *Geoph. J. R. Astron. Soc.* **66**, 481—490.
Meju, M. A., and Hutton, V. R. S.: 1986, 'An Interpretative Analysis of Magnetotelluric Measurements Across the Great Glen Fault, North Scotland', Proc. UK Geophysical Assembly X, *Geoph. J. R. Astron. Soc.* (abstract only)
Mbipom, E. W., and Hutton, V. R. S.: 1983, 'Geoelectromagnetic Measurements across the Moine Thrust and the Great Glen in Northern Scotland', *Geoph. J. R. Astron. Soc.* **74**, 507—524.
Sik, J., Hutton, V. R. S., Dawes, G., and Kirkwood, S.: 1981, 'A Geomagnetic Variation Study of Scotland', *Geoph. J. R. Astron. Soc.* **66**, 491—512.
Sule, P. O, and Hutton, V. R. S.: 1986, 'A Broadband Magnetotelluric Study in South-Eastern Scotland: Data Acqusition, Analysis and One-dimensional Modelling', *Ann. Geophys.* **4**, B2, 145—156.

A5. Travale/Toscana Geothermal Studies

Berktold, A. J., Dittus, H. J., Eigner, K.-H., and Teufel, U.: 1985, 'Investigation of the Geothermal Anomaly of Travale (Tuscany) by Telluric, Magnetotelluric and Geomagnetic Deep Sounding Measurements', *Geothermics,* **14**, 663—672.
Duprat, A., and Gole, F.: 1985, 'Magnetotelluric Soundings in the Travale Area, Tuscany', *Geothermics,* **14**, 689—696.
Duprat, A., Roudot, M., and Spitz, S.: 1985, 'A Test of the Transiel Method on the Travale Geothermal Field', *Geothermics* **14**, 705—712.
Hutton, V. R. S.: 1985, 'Magnetic, Telluric and Magnetotelluric Measurements at the Travale Test Site, Tuscany 1980—1983: An Overview', *Geothermics* **14**, 637—644.
Hutton, V. R. S., Dawes, G. J. K., Devlin, T., and Roberts, R.: 1985, 'A Broadband Tensorial Magnetotelluric Study in the Travale Geothermal Field', *Geothermics* **14**, 645—652.
LeMasne, D.: 1985, 'Tests of Electric and Electromagnetic Methods in the Travale Geothermal Field', *Geothermics* **14**, 697—703.
Mosnier, J., and Planson, F.: 1985, 'Differential Magnetic Soundings in the Travale Geothermal Area', *Geothermics* **14**, 749—754.
Otten, J., and Musmann, G.: 1985, 'Application of Active Audiomagnetotellurics (AAMT) in the Geothermal Field of Travale, Tuscany', *Geothermics* **14**, 673—688.
Schwarz, G.: 1984, 'Die elektrische Leitfähigkeit in der Toskana und ein daraus abgeleitetes geothermisches Modell — insbesondere für die Anomalie von Travale', Berliner Geowiss. Abh. Reihe B, Heft 8, 95 pp.
Schwarz, G., Haak, V., and Rath, V.: 1985, 'Electrical Conductivity Studies in the Travale Geothermal Field, Italy', *Geothermics* **14**, 653—661.
Van Ngoc, P., Boyer, D., and Kieffer, G.: 1982, 'Sur la structure interne profonde d'un secteur du flanc sud de l'Etna et sa relation avec l'évolution structurale du volcan sicilien', *C.R. Acd. Sc. Paris* **295**, Ser II, 891—894.

A6. Geotraverses

A6.1. EGT

Berktold, A.: 1986, 'The Conductivity Distribution in the Middle and Lower Crust of Central Europe, Compilation of Data — New Results', Manuscript, 4 + 6 pp.
Haak, V.: 1985a, 'Geodynamic Significance of Electrically Well Conducting Structures in the Crust and Upper Mantle — With Reference to the EGT', in Galson, D. A., Müller, St. (eds.), Proc. Second Workshop on the European Geotraverse (EGT) Project, European Science Foundation, July 1985.
Haak, V.: 1985b, 'A Geoelectric Cross Section along the Central and Southern Part of the European Geotraverse', *Terra Cognita* **5**, 161 (abstract only).
Hjelt, S. E.: 1985, 'Preliminary Notes Concerning the Geoelectric Structure of the EGT Northern Segment', *Terra Cognita* **5**, 158 (abstract only).
Müller, W., and Losecke, W.: 1985, 'Magnetotelluric Results from the Northern Apennines and the Po Basin and Recent Progress in Magnetotelluric Techniques', in Galson, D. A., Müller, St. (eds.), *Proc.*

Second Workshop on the European Geotraverse (EGT) Project, European Science Foundation, July 1985 (abstract only).

Symposium on the European Geotraverse Project, Papers presented at EUG III, April 1—4, 1985, Strasbourg, France, *Terra Cognita* **5**, 156—163 (abstracts only).

A6.2. ECORS

Gazes, M., Torreilles, G., Bois, C., Damotte, B., Galdéano, G., Hirn, A., Mascle, A., Matte, P., Van Ngoc, P., and Raoult, J.-F.: 1985, 'Structure de la croute hercynienne du Nord de la France: premiers résultats du profil ECORS', Bull. Soc. Géol. Fr. (8), t. I, No. 6, 925—941.

Van Ngoc, P., and LeMouel, J. L.: 1985, 'Electrical Properties of the Earth's Crust along Profile "North of France" (ECORS Programme) by Deep Magnetotelluric Soundings", *Terra Cognita* **5**, 301 (abstract only).

A6.3. KAPG Geotraverses

Ingerov, A. I., and Rokityansky, I. I.: 1986, 'Deep Magnetotelluric Soundings on the Ukrainian Shield', (in Russian), *Geoph. Zurnal AN Ukr. SSR* **8**: 3, 3—13.

B. ASIA

B1. India

Arora, B. R., Lilley, F. E. M., Sloane, M. N., Singh, B. P., Srivastava, B. J., and Prasad, S. N.: 1982, 'Geomagnetic Induction and Conductive Structures in North-West India', *Geoph. J. R. Astron. Soc.* **69**, 459—475.

Arora, B. R., and Mahashabde, M. V.: 1987, 'A Transverse Conductive Structure in the Northwest Himalaya', *Phys. Earth Planet. Inter.* **45**, 119—127.

Chamalaun, F. H., Prasad, S. N., Lilley, F. E. M., Srivastava, B. J., Singh, B. P., and Arora, B. R.: 1986, 'On the Interpretation of the Distinctive Pattern of Geomagnetic Induction Observed in North-West India', *Manuscript,* 19 + 5 pp.

Lilley, F. E. M., Singh, B. P., Arora, B. R., Srivastava, B. J., Prasad, S. N., and Sloane, M. N.: 1981, 'A Magnetometer Array Study in North-West India', *Phys. Earth Planet. Inter.* **25**, 232—240.

Nityananda, N., Agarwal, A. K., and Singh, B. P.: 1981, 'An Explanation of Induced Magnetic Variations at Sabhawala, India', *Phys. Earth Planet. Inter.* **25**, 226—231.

Nityananda, N., and Jayakumar, D.: 1983, 'Proposed Relation between Anomalous Geomagnetic Variations and the tectonic History of South India', *Phys. Earth Planet. Inter.* **27**, 223—228.

Ramaswamy, V., Agarwal, A. K., and Singh, B. P.: 1985, 'A Three-dimensional Numerical Model Study of Electromagnetic Induction around the Indian Peninsula and Sri Lanka Island', *Phys. Earth Planet. Inter.* **39**, 52—61.

Srivastava, B. J., Singh, B. P., and Lilley, F. E. M.: 1984, 'Magnetometer Array Studies in India and the Lithosphere', *Tectonophysics* **105**, 355—371.

Srivastava, B. J., Prasad, S. N., Singh, B. P., Arora, B. R., Thakur, N. K., and Mahashabde, M. V.: 1982, 'Induction Anomalies in Geomagnetic S_q in Peninsular India', *Geophys. Res. Lett.* **9**, 1135—1138.

Takeda, M., and Maeda, H.: 1979, 'Effect of the Coast-line Configuration of South India and Sri Lanka Region on the Induced Field at Short Period', *J. Geophys.* **45**, 209—218.

Thakur, N. K., Mahashabde, M. V., Arora, B. R., Singh, B. P., Srivastava, B. J., and Prasad, S. N.: 1981, 'Anomalies in Geomagnetic Variations on Peninsular India near Palk Strait', *Geophys. Res. Lett.* **8**, 947—950.

Vozoff, K.: 1984, 'Model Study for the Proposed Magnetotelluric (MT) Traverse in North India', *Tectonophysics* **105**, 399—411.

B2. Siberia

Avagimov, A. A., Ashirov, T. A., Berdichevsky, M. N., Dubrovskiy, V. G., Dubrovskaya, Ye. V., Il'amanov, K., Lagutinskaya, L. P., Nepesov, K., Smirnov, Ya. B., Sopiyev, V. A., Tavnelova, O. M., and Fainberg, E. B.: 1981, 'Geoelectrical and Thermal Model of the Deep Structure of Southern Turanian Plate', *Phys. Solid Earth, Bull AN SSSR* **17**: 7, 15—28.

Berdichevsky, M. N., Vanyan, L. L., Kuznetsov, V. A., Levadny, V. T., Mandelbaum, M. M., Nechaeva, G. P., Okulessky, B. A., Shilovsky, P. P. and Shpak, I. P.: 1980, 'Geoelectrical Model of the Baikal Region', *Phys. Earth Planet. Inter.* **33**, 1—11.

Babadzhanor, T. L., Basov, M. D., Gatina, P. M., Ashirmatov, A. S., Belyavskiy, V. V., Karzhauv, A. T., Tal'-Virskiy, B. B., Dubrovskiy, V. G., Berdichersky, M. N., Yakovlev, A. G., Faynberg, E. B.: 1986, 'The Southern Tien-Shan Electrical Conductivity Anomaly', *Phys. Solid Earth, Bull AN SSSR* **22**: 576—584.

Debabov, A. S., Demidova, T. A., and Yanikyan, V. O.: 1984, 'Results of Spectral Iteration Modeling of a Magnetotelluric Field in Armenia', *Phys. Solid Earth, Bull AN SSSR* **20**, 556—562.

Demidova, T. A., Yegorov, I. V., and Yanikyan, V. O.: 1985, 'Galvanitcheskie iskaschenija magnetotellurischeskogo polja Malogo Kavkaza', *Geomagnetism and Aeronomy* **25**: 3, 474—481.

Ingerov, A. I., Rokityansky, I. I., Rokityanskaya, D. A., and Schuman, V. N.: 1985, 'Geoelectric Cross-Section along the Part Vinnitsa- Evpatorija of the Geotraverse VI (in Russian)', *Geoph. Zurnal AN Ukr. SSR* **7**: 5, 69—74.

Ingerov, A. I., and Rokityansky, I. I.: 1986, 'Depth Magnetotelluric Soundings on the Ukrainian Shield' (in Russian, Engl. abstract)', *Geoph. Zurnal AN Ukr. SSR* **8**: 3, 3—13.

Moroz, Yu., F.: 1984, 'On the Deep Structure of Eastern Kamchatka Obtained from Magnetotelluric Soundings (in Russian)', *Vulkanologija i seismologija* 1984: 5, 85—90.

Nikiforov, V. M., Alperovitch, I. M., and Vanyan, L. L.: 1983, 'Some Peculiar Curves of Magnetotelluric Sounding on Sakhalin and Methods for their Interpretation (in Russian)', *Tikhookeanskaja Geologija* 1983: 5, 59—65.

Shilovsky, A. P.: 1985, 'Deep Electrical Conductivity in Eastern Siberia', *Acta Geod. Geophys. et Montan. Hung.* **20**, 183—185.

Zinger, B. Sh., Dubrovskiy, V. G., Fainberg, E. B., Berdichevsky, M. N., Il'amanov, K.: 1984, 'Quasi-three-dimensional Modeling of Magnetotelluric Fields in the Southern Turanian Plate and the South Caspian Megabasin', *Phys. Solid Earth, Bull AN SSSR* **20**: 1, 69—81 (engl. transl. pp. 52—61).

B3. China

Gu Qun, Sun Jie, Shi Shulin, and Shi Zhangsong: 1980, 'The Features of Highly Electrical Conductivity Layer in North China and Northwest China Regions (in Chinese, abstract in English), *Seismology and Geology (Dizhen Dizhi)*, 2: 2, 21—29.

Lin Chang-you, Zhang Yun-lin, Shi Yu-lan, Jian Mei, and Li Zhu-guo: 1984, 'On the Magnetotelluric Research in the Eastern Region of the He-Xi Corridor', (in Chinese, abstract in English), *Acta Geophysica Sinica* **27**, 131—143.

Francheteau, J., Jaupart, C., Allegre, C. J., Courtillot, V., and Cheng, Y.: 1982, 'Heat Flow Measurements in Tibet', (abstract only), *EOS Trans,* **63**, No. 45, 1092.

Liu Guodong, Gu Qun, Shi Shulin, Sun Jie, Shi Zhang-song, and Liu Jinhan: 1983, 'The Electrical Structure of the Crust and Upper Mantle and its Relationship with Seismicity in the Beijing-Tianjin-Tangshan Region and Adjacent Area', (in Chinese, abstract in English), *Acta Geophysica Sinica* **26**: 2, 149—157.

Liu Guodong, Shi Shulin, and Wang Baojun: 1984, 'Conductive Layer in the Crust in North China and its Relation to Crustal Tectonism', *Scientia Sinica,* Ser **B 27**, 1093—1104.

Ma Xingyan, Liu Guodang, and Su Juan: 1984, 'The Structure and Dynamics of the Continental Lithosphere in North-northeast China', *Ann. Geophysicae* **2**, 611—620.

State Seismological Bureau, Mangnetotelluric Sounding Group: 1984, 'Deep-seated Electric Conductivity in the Tangshan Area, China', (in Chinese, abstract in English), *Seismology and Geology (Dizhen Dizhi)* **6**: 2, 1—5.

Van Ngoc, P., Boyer, D., and Therme, P.: 1983, 'Electrical Properties of the Earth's Crust by Deep Magneto-telluric Soundings from Yong Ba Jain to Lhozag (Tibet)', *Terra Cognita* **3**, 270.

Van Ngoc, P., Boyer, D., Therme, P., Yuan, X. C., Li L., and Jin, G. Y.: 1986, 'Partial Melting Zones in the Crust on Southern Tibet from Magnetotelluric Results', *Nature* **319**, No. 6051, 310—314.

Wang Baojun, and Gao Weian: 1984, 'A Finite Element Approach to Magnetotelluric Sounding Data for the Two-dimension Structures in the Beijing-Tianjin-Tangshan Area', (in Chinese, abstract in English), *Seismology and Geology (Dizhen Dizhi)* **6**: 1, 69—80.

Zhao Guoze, and Zhao Yonggui: 1984, 'Correlation between the Structures of Crust and Upper Mantle and the Thermal Events', (in Chinese, abstract in English), *Seismology and Geology (Dizhen Dizhi),* **6**: 3, 49—57.

B4. Japan and Pacific

Chave, A. C., VonHerzen, R. P., Poehls, K. A., and Cox, C. S.: 1981, 'Electromagnetic Induction Field in the Deep Ocean North-east of Hawaii: Implications for Mantle Conductivity and Source Fields', *Geophys. J.R. Astron. Soc.* **66**, 379—406.

Filloux, J. H.: 1980, 'Magnetotelluric Soundings over the Northeast Pacific may reveal Spatial Dependence of Depth and Conductance of the Asthenosphere', *Earth Planet. Sci. Lett.* **46**, 244—252.

Filoux, J. H.: 1981, 'Magnetotelluric Exploration of the North Pacific: Progress Report and Preliminary Soundings near a Spreading Ridge', *Phys. Earth Planet. Inter.* **25**, 187—195.

Filloux, J. H.: 1982, 'Magnetotelluric Experiment over the ROSE Area', *J. Geophys. Res.* **87**, 8.364—8.378.

Honkura, Y.: 1982, 'Electrical Conductivity Structure Beneath Oceans', *Earth Man.* **4**, 311—318. (in Japanese)

Honkura, Y.: 1983, 'Peninsula Effect in Central Japan and their Relation to the Electrical Conductivity Structure', *J. Geomag. Geoelectr.* **35**, 39—56.

Honkura, Y., Isezaki, N., and Yaskawa, K.: 1983, 'Electrical Conductivity Structure beneath the North-western Philippine Sea as inferred from the Island Effect on Minami-daito Island', *J. Geomag. Geoelectr.* **35**, 365—377.

RESEARCH GROUP for CRUSTAL RESISTIVITY STRUCTURE, Japan: 1983, 'Preliminary Report on a Study of Resistivity Structure beneath the Northern Honyu of Japan', *J. Geomag. Geoelectr.* **35**, 589—608.

Sato, S.: 1981, 'Upper Mantle Conductivity Structures in North Eastern Japan from Magneto-telluric Data', *Butsuri-Tanko (Geophys. explor.)* **34**, 56—68.

Yukutake, T., Filloux, J. H., Segawa, J., Hamano, Y., and Utada, H.: 1983, 'Preliminary Report on a Magnetotelluric Study in the Northwest Pacific', *J. Geomag. Geoelectr.* **35**, 575—587.

B5. Australia

Chamalaun, F. H.: 1985, 'Geomagnetic Deep Sounding Experiment in the Central Flinders Ranges of South Australia', *Phys. Earth Planet. Inter.* **37**, 174—182.

Constable, S. C.: 1983, 'Deep Resistivity Studies of the Australian Crust', Thesis (unpubl.) Australian National Univ., Canberra.

Constable, S. C.: 1985a, 'Resistivity Studies over the Flinders Conductivity Anomaly, South Australia', *Geophys. J. R. Astron. Soc.* **83**, 775—786.

Constable, S. C.: 1985b, 'Electrical Studies of the Australian Crust: a Review', Aust. J. Earth Sci. (subm.)

Constable, S. C., McElhinny, M. W., and McFadden, P. L.: 1984, 'Deep Schlumberger Sounding and the Crustal Resistivity Structure of Central Australia', *Geophys. J. R. Astron. Soc.* **79**, 893—910.

Ferguson, I. J., Filloux, J. H., Lilley, F. E. M., Bindoff, N. L., and Mulhearn, P. J.: 1985, 'A Seafloor Magnetotelluric Sounding in the Tasman Sea', *Geophys. Res. Letters* **12**, 545—548.

Filloux, J. H., Lilley, F. E. M., Ferguson, I. J., Bindoff, N. L., and Mulhearn, P. J.: 1985, 'The Tasman Project of Seafloor Magnetotelluric Exploration', *Explor. Geophysics (Bull. Austr. Soc. Explor. Geophys.)* **16**, 221—224.

Finlayson, D. M.: 1982, 'Geophysical Differences in the Lithosphere between Phanerozoic and Precambrian Australia', *Tectonophysics* **84**, 287—312.

Ingham, M. R.: 1985a, 'Magnetotelluric Measurements in the Wellington Region', *New Zealand J. of Geology and Geophysics* **28**, 397—404.

Ingham, M. R.: 1985b, 'Magnetovariational Measurements in the Cook Strait Region of New Zealand', *Phys. Earth Planet. Inter.* **39**, 182—193.

Lilley, F. E. M.: 1982, 'Geomagnetic Field Fluctuations over Australia in relation to Magnetic Surveys', *Bull. Austr. Soc. Explor. Geophys.* **13**, 68—76.

Lilley, F. E. M.: 1984, 'On the Spatial Pattern of Magnetic Fluctuations in the Cobar Area, NSW', *Explor. Geophysics (Bull. Austr. Soc. Explor. Geophys.)* **15**, 79—83.

Lilley, F. E. M., and Sloane, M. N.: 1981a, 'Ideal Phase in Estimating the Spatial Gradient of Magnetic Daily Variations Recorded by Magnetometer Arrays', *J. Geomag. Geoelectr.* **33**, 517—525.

Lilley, F. E. M., Woods, D. V., and Sloane, M. N.: 1981b, 'Electrical Conductivity from Australian Magnetometer Arrays using Spatial Gradient Data', *Phys. Earth Planet. Inter.* **25**, 202—209.

Lilley, F. E. M., Woods, D. V., and Sloane, M. N.: 1981c, 'Electrical Conductivity Profiles and Implications for the Absense or Presence of Partial Melting beneath Central and Southeast Australia', *Phys. Earth Planet. Inter.* **25**, 419—428.

Strack, K. M.: 1984, 'The Deep Transient Electromagnetic Sounding Technique: First Field Test in Australia', *Explor. Geophysics (Bull. Austr. Soc. Explor. Geophys.)* **15**, 251—259.

White, A., and Milligan, P. R.: 1987, 'Geomagnetic Variations across the Southern Adelaide Geosyncline, South Australia', J. Geomag. Geoelectr. (in print)

White, A., and Polatajko, O. W.: 1985, 'Electrical Conductivity Anomalies and Relationship with the Tectonics of South Australia', *Geophys. J. R. Astron. Soc.* **80**, 757—771.

C. AFRICA

Albouy, Y., Babour, K., and Guetat, Z.: 1982, 'Anomalie de conductivité au Sénegal Oriental', *Cah. ORSTOM, Ser. Geophys.* **19** 11—20.

DeBeer, J. H., Van Zijl, J. S. V., and Gough, D. I.: 1982, 'The Southern Cape Conductive Belt (South Africa): Its Composition, Origin and Tectonic Significance', *Tectonophysics* **83**, 205—225.

Menvielle, M., and Le Mouël, J. L.: 1985, 'Existence d'une anomalie de conductivité dans le Haut Atlas marocain et concentration des courants telluriques á l'échelle régionale', *Bull. Soc. Géol. France,* 553—558.

Menvielle, M., and Rossignol, J. C.: 1982, 'Consequences tectoniques de lexistence d'une anomalie de conductivité électrique au Nord du Maroc, *Can J. Earth Sci.* **19**, 1507—1517.

Ogunade, S. O.: 1983, 'A Perspective of the Induction Studies in South Western Nigeria', *J. Geomag. Geoelectr.* **35**, 567—573.

Ritz, M.: 1982a, 'Sondage magnétotellurique profond sur le craton ouest africain (République de Haute-Volta). Esquisse de modéles pour le craton ouest-africain', *J. Geomag. Geoelectr.* **34**, 447—452.

Ritz, M.: 1982b, 'Etude régionale magnétotellurique des structures de la conductivité électrique sur la bordure occidentale du craton ouest africaine en République du Sénegal', *Can. J. Earth Sci.* **19**, 1408—1416.

Ritz, M.: 1983a, 'Use of the Magnetotelluric Method for a better Understanding of the West African Shield', *J. Geophys. Res.* **88**: B12, 10.625—10.633.

Ritz, M.: 1983b, 'The Distribution of Electric Conductivity on the Eastern Boarder of the West African Craton (Republic of Niger)', *Geoph. J. R. Astron. Soc.* **73**, 475—488.

Ritz, M.: 1984a, 'Electrical Resistivity Structure of the Senegal Basin as Determined from Magnetotelluric and Differential Geomagnetic Soundings', *Geoph. J. R. Astron. Soc.* **79**, 635—649.

Ritz, M.: 1984b, 'Inhomogeneous Structure of the Senegal Lithosphere from Deep Magnetotelluric Soundings', *J. Geophys.* **89**: B13, 11.317—11.331.

Ritz, M., and Vassal, J.: 1987, 'Geoelectromagnetic Measurements across the Southern Senegal Basin (West Africa)', *Phys. Earth Planet. Inter.* **45**, 75—84.

Schwarz, G.: 1986, 'Ein Datenkatalog mit den Ergebnissen der magnetotellurischen Messungen im Atlas-System von Marokko', DFG-Bericht, Inst. Geophys. Wiss., Freie Univ. Berlin.

Schwarz, G., Rath, V., and Haak, V.: 1986, 'Magnetotellurische und erdmagnetische Sondierungen im Marokkanischen Atlas', *Berliner Geowiss. Abh. (A)* **66**, 289—300.

Van Ngoc, P., et al.: 1980, 'Propriétés électriques de la croute et du manteau supérieur du rift d'Asal (Djibouti) d'après les sondages magnéto-telluriques profonds', *Bull. Soc. Géol. France (7) t. XXII, 6,* 863—871.

D. AMERICA

D1. Canada

Bingham, D. K., Gough, D. I., and Ingham, M. R.: 1985, 'Conductive Structures under the Canadian Rocky Mountains', *Can. J. Earth Sci.* **22**, 385—398.

Camfield, P. A.: 1981, 'Magnetometer Array Study in a Tectonically Active Region of Quebec, Canada', *Geophys. J. R. Astron. Soc.* **65**, 553—570.

DeLaurier, J. M., Plet, F. C., and Drury, M. J.: 1981, 'A Geomagnetic Depth Sounding Profile Across the Northern Yukon and the Mackenzie Delta Region', *Can. J. Earth Sci.* **18**, 1092—1100.

DeLaurier, J. M., Auld, D. R., and Law, L. K.: 1983, 'The Geomagnetic Response across the Continental Margin off Vancouver Island: Comparison of Results from Numerical Modelling and field Data', *J. Geomag. Geoelectr.* **35**, 517—528.

Edwards, R. N., Law, L. K., Wolfgram, P. A., Nobes, D. C., Bone, M. N., Trigg, D. F., and DeLaurier, J. M.: 1985, 'First Results of the MOSES Experiment: Sea Sediment Conductivity and Thickness Determination, Bute Inlet, British Columbia, by Magnetometer Offshore Electrical Sounding', *Geophysics* **50**, 153—161.

Flores, C., Kurtz, R. D., and DeLaurier, J. M.: 1985, 'Magnetotelluric Exploration in the Meager Mountain Geothermal Area, Canada', *Acta Geod. Geoph. et Montan. Hung.* **20**, 165—171.

Gough, D. I.: 1986a, 'Mantle Upflow Tectonic in the Canadian Cordillera', *J. Geophys. Res.* **91**, 1909—1920.

Gough, D. I.: 1986b, 'Magnetotelluric Evidence for Subduction of Seafloor Sediments', *Nature* **321**, No. 6070, 566.

Gough, D. I., Bingham, D. K., Ingham, M. R., and Alabi, A. O.: 1982, 'Conductive Structure in Southwestern Canada: A Regional Magnetometer Array Study', *Can. J. Earth Sci.* **19**, 1680—1690.

Gupta, J. C., Kurtz, R. D., Camfield, P. A., and Niblett, E. R.: 1985, 'A Geomagnetic Induction Anomaly from IMS Data near Hudson Bay, and its Relation to Crustal Electrical Conductivity in Central North America', *Geophys. J. R. Astron. Soc.* **81**, 33—46.

Handa, S., and Camfield, P. A.: 1984, 'Crustal Electrical Conductivity in North-central Saskatchewan: The North American Central Plains Anomaly and its Relation to a Proterozoic Plate Margin', *Can. J. Earth Sci.* **21**, 533—543.

Hutton, V. R. S., Gough, D. I., Dawes, G. J. K. and Travassos, J.: 1987, 'Magnetotelluric Soundings in the Canadian Rocky Mountains', *Geophys. J. R. Astron. Soc.* **90**, 245—263.

Ilkisik, O. M., Redman, J. D., Hsu, D. T., and Strangway, D. S.: 1983, 'AMT Sounding Through Conductive Glacial Clays in the Canadian Shield', *J. Geomag. Geoelectr.* **35**, 455—472.

Ingham, M. R., Bingham, D. K., and Gough, D. I.: 1983, 'A Magnetovariational Study of a Geothermal Anomaly', *Geophys. J. R. Astron. Soc.* **72**, 597—618.

Jones, A. G.: 1983, 'Electromagnetic Investigations in Eastern Canada — A Concise Review', in Hjelt S. E (ed.), *The Development of the Geoelectric Model of the Baltic Shield*, Part 2. Proceedings of the 1st project symposium, Oulu, 15.—18.11.1983, Department of Geophysics, University of Oulu, Report, No. 8, pp. 166—178.

Jones, A. G., and Garland, G. D.: 1986a, 'Electromagnetic Sounding from Observations taken during the First International Polar Year', MUSK—OX 34, 35—43.

Jones, A. G., and Garland, G. D.: 1986b, 'Preliminary Interpretation of the Upper Crustal Structure Beneath Prince Edward Island', *Ann. Geophysicae*, **4**: B2, 157—164.

Jones, A. G., and Savage, P. J.: 1986c, 'North American Central Plains Anomaly Goes East', *Geophys. Res. Lett.* **13**, 685—688.

Kurtz, R. D.: 1982, 'Magnetotelluric Interpretation of Crustal and Mantle Structure in the Grenville Province', *Geophys. J. R. Astron. Soc.* **70**, 373—397.

Kurtz, R. D., and Niblett, E. R.: 1984, 'A Magnetotelluric Survey over the East Bull Lake Gabbro-Anorthosite Complex', Atomic Energy of Canada Ltd./EDA Technical Record TR-236.

Kurtz, R. D., and Niblett, E. R.: 1985, Electromagnetic Studies of the Asthenosphere in the Canadian Shield, (manuscript).

Kurtz, R. D., DeLaurier, J. M, and Gupta, J. C.: 1986, 'A Magnetotelluric Sounding Across the Vancouver Island Detects the Subducting Juan de Fuca Plate', *Nature* **321**, 596—599.

Kurtz, R. D., Niblett, E. R., Chouteau, M., Scott, W. J., and Newitt, L. R.: 1980, 'An Anomalous Electrical Resistivity Zone near Ste-Mathilde, Quebec', *J. of the Can. Soc. of Explor. Geoph.* **16**, 56—67.

Kurtz, R. D., Ostrowski, J. A., and Niblet, E. R.: 1986, 'A Magnetotelluric Survey over the East Bull Lake Gabbro-Anorthosite Complex', *J. Geophys. Res.* **91**, B7, 7403—7416.

Law, L. K. and Greenhouse, J. P.: 1981, 'Geomagnetic Variation Sounding of the Asthenosphere Beneath the Juan de Fuca Ridge', *J. Geophys. Res.* **86**, 976—978.

McCollor, D. C., Chapel, B. E., Watanabe, T., Slawson, W. F., and Shier, R. M.: 1982, 'E. M. Exploration with Power Line Harmonic Fields', *EOS, Trans. Amer. Geophys. Union* **63**, 910.

McCollor, D. C., Watanabe, T., Slawson, W. F., and Shier, R. M.: 1983, 'An E. M. Method for Earth Resistivity Measurements Using Power Line Harmonic Fields', *J. Geomag. Geoelectr.* **35**, 221—244.

Nienaber, W., Hibbs, R. R., Dosso, H. W., and Law, L. K.: 1982, 'An Estimate of the Conductivity

Structure of the Vancouver Island Region from Geomagnetic Results', *Phys. Earth Planet. Inter.* **27**, 300—335.

Oldenburg, D. W.: 1981, 'Conductivity Structure of Oceanic Upper Mantle Beneath the Pacific Plate', *Geophys. J. R. Astron. Soc.* **65**, 359—394.

Oldenburg, D. W., Whittall, K. P., and Parker, R. L.: 1984, 'Inversion of Ocean Bottom Magnetotelluric Data Reviseted', *J. Geophys. Res.* **89**, 1829—1833.

Prugger, A. F., and Woods, D. V.: 1984, 'The Pattern of Anomalous Geomagnetic Variation Fields over the Midcontinental Gravity High', *J. Geophys. Res.* **89**, B9, 7773—7782.

Woods, D. V.: 1985, 'Large-Scale Electromagnetic Induction Investigation of the Kapuskasing Structural Zone, Northern Ontario', in Current Res., Part A, Geol Survey of Canada, Paper 85-1A, pp. 533—542.

Woods, D. V., and Allard, M.: 1986, 'Reconnaissance Electromagnetic Induction Study of the Kapuskasing Structural Zone: Implications for Lower Crustal Conductivity', *Phys. Earth Planet. Inter.* **42**, 135—142.

D2. Iceland

Beblo, M., and Björnsson, A.: 1985, 'Magnetotelluric Results in North-East Iceland — Electrical Conductivity, Temperature, Crust and Mantle Structure', *Acta Geod. Geoph. et Montan. Hung.* **20**, 153—158.

Beblo, M., Björnsson, A., Árnason, K., Stein, B., and Wolfgram P.: 1983, 'Electrical Conductivity Beneath Iceland- Constraints Imposed by Magnetotelluric Results on Temperature, Partial Melt, Crust and Mantle Structure', *J. Geophys.* **53**, 16—28.

Eysteinsson, H., and Hermance, J. F.: 1985, 'Magnetotelluric Measurements across the Eastern Neovolcanic Zone in South Iceland', *J. Geophys. Res.* **90**, B12, 10.093—10.103.

Flovenz, O. G., Georgsson, L. S. and Árnason, K.: 1985, 'Resistivity Structure of the Upper Crust in Iceland', *J. Geophys. Res.* **90**, B12, 10.136—10.150.

Georgsson, L. S.: 1981, 'A Resistivity Survey on the Plate Boundaries in the Western Reykjanes Peninsula, Iceland', *Trans. Geotherm. Resourc. Counc.* **5**, 75—78.

Haak, V.: 1983, 'Sind Island und Afar basalt-arme Mantel-Diapire? Argumente aus der Verteilung der elektrischen Leitfähigkeit', *Habilit. Schrift*, Freie Univ. Berlin, 118 pp.

Hermance, J. F.: 1981, 'Crustal Genesis in Iceland: Geophysical Constraints on Crustal Thickening with Age', *Geophys. Res. Lett.* **8**, 203—206.

Hersir, G. P., Björnsson, A., and Pedersen, L. B.: 1984, 'Magnetotelluric Survey Across the Active Spreading Zone in Southwest Iceland', *J. Volcanol. Geotherm. Res.* **20**, 253—256.

Schmeling, H.: 1984a, 'Partial Melt in the Asthenosphere and in the Upper Mantle Below Iceland — A Combined Interpretation of Seismic and Geoelectric Data', *Terra Cognita* **4**, 104—105 (abstract only).

Schmeling, H.: 1984b, 'Constraints on the Degree and Geometry of Partial Melt in the Oceanic Asthenosphere and Beneath Iceland', *Terra Cognita* **4**, 255—256 (extended abstract).

Schmeling, H.: 1985, 'Partial Melt Below Iceland: A Combined Interpretation of Seismic and Conductivity Data', *J. Geophys. Res.* **90**, B12, 10.105—10.116.

Thayer, R. E., Björnsson, A., Alvarez, L., and Hermance, J. F.: 1981, 'Magma Genesis and Crustal Spreading in the Northern Neovolcanic Zone of Iceland: Telluric and Magnetotelluric Constraints', *Geoph. J. R. Astron. Soc.* **65**, 423—442.

D3. South America

Baldis, B., Demicheli, J., Febrer, J., Fournier, H., Garcia, E., Gasco, J. C., Mamani, M., and Pomposiello, C.: 1983, 'Magnetotelluric Diversified Results along a 1200 km Long Profile Showing at its North-West End an Important Geothermal Area in the Provinces of Tucuman and Santiago del Estero in Argentina', *J. Geomag. Geoelectr.* **35**, 609—621.

Baldis, B., Bemicheli, J., Febrer, J., Fournier, H., Garcia, E., Gasco, J. C., Mamani, M., and Pomposiello, C.: 1983, 'Magnetotelluric Results along a 1200 km Long Deep Profile with an Important Geothermal Area at its North-West End in the Provinces of Tucuman and Santiago del Estero in Argentina', *Acta Geod. Geoph. et Mont. Hung.* **18**, 489—499.

Febrer, J. Baldis, B., and Fournier, H.: 1980, 'Sondaje magnetotelurico profundo en Chamical, La Rioja', *Geoacta* **10**.

Gasco, J. C., Febrer, J., Demicheli, J., and Fournier, H.: 1982, 'Zarate M-T Sounding and Upper Mantle Resistivity', *Acta Geod. Geoph. et Mont. Hung.* **17**, 307—309.

Haak, V., and Giese, P.: 1986, 'Subduction Induced Petrological Processes as Inferred from Magnetotelluric, Seismological and Seismic Observations in N-Chile and S-Bolivia', *Berliner Geowiss. Abh. (A)* **66**, 231—246.

Schwarz, G.: 1985, 'Ein Datenkatalog mit den Ergebnissen der magnetotellurischen Messungen in den Zentralen Anden von Nord-Chile und Süd-Bolivien', DFG-Bericht, Inst. Geophys. Wiss., Freie Univ. Berlin.

Schwarz, G., Haak, V., Martinez, E., and Bannister, J.: 1984, 'The Electrical Conductivity of the Andean Crust in Northern Chile and Southern Bolivia as Inferred from Magnetotelluric Measurements', *J. Geophys.* **55**, 169—178.

Schwarz, G., Martinez, E., and Bannister, J.: 1984, 'Die Verteilung der elektrischen Leitfähigkeit aus Magnetotellurik-Messungen', *Terra Cognita* **4** 107 (abstract only).

Schwarz, G., Martinez, E., and Bannister, J.: 1985, 'Untersuchungen zur elektrischen Leitfähigkeit in den Zentralen Anden', *Berliner Geowiss. Abh. (A)* **66**, 49—72.

Tarits, P., and Menvielle, M.: 1986, 'The Andean Conductivity Anomaly Reexamined', *Ann. Geophysicae* **4B**, 63—70.

Vatin-Perignon, N., Pomposiello, C., Mamani, M., Maidana, A., Keller, M., Gasco, J. C., Fournier, H., and Febrer, J.: 1985, 'The Hot Dome of Taco Ralo in the NW of Argentina', *Acta Geod. Geoph. et Mont. Hung.* **20**, 159—163.

D4. U.S.A. and Mexico

Ander, M. E.: 1984, 'A Detailed Magnetotelluric/Audiomagnetotelluric Study of the Jemez Volcanic Zone, New Mexico', *J. Geophys. Res.* **89**, B5, 3335—3353.

Ander, M. E., Goss, R., Strangway, D., Hillebrand, C., Laughlin, A. W., and Hudson, C.: 1980, 'Magnetotelluric/Audiomagnetotelluric Study of the Zuni Hot Dry Rock Prospect, New Mexico', *Geothermal Resources Council Trans.* **4**, 5—8.

Gamble, T. D., Goubau, W. M., Goldstein, N. E., Miracky, R., Stark, M., and Clarke, J.: 1981, 'Magnetotelluric Studies at Cerro Prieto', *Geothermics* **10**, 169—182.

Goldstein, N. E., Mozley, E., and Wilt, M.: 1982, 'Interpretation of Shallow Electrical Features from Electromagnetic and Magnetotelluric Surveys at Mount Hood, Oregon', *J. Geophys. Res.* **87**, B4, 2815—2828.

Greenhouse, J. P., and Bailey, R. C.: 1981, 'A Review of Geomagnetic Measurements in the Eastern United States: Implications for Continental Tectonics', *Can. J. Earth Sci.* **18**, 1268—1289.

Group Seven, Inc.: 1981, 'Western Nevada Magnetotelluric Survey', Internal Report, 24 + 6 pp.

Group Seven, Inc.: 1981, 'Clear Lake, California, Magnetotelluric Survey', Internal Report, 22 + 6 pp.

Group Seven, Inc.: 1981, 'Snake River Plain/Southeastern Oregon Magnetotelluric survey', Internal Report, 24 + 6 pp.

Group Seven, Inc.: 1982, 'Southwestern United States Magnetotelluric Survey', Internal Report, 24 + 6 pp.

Hermance, J. F., and Karlsdottir, R.: 1986, 'The Major Boundary Faults in Eastern Long Valley Caldera; Magnetotelluric and Gravity Constraints', *Geophys. Res. Letters* **13**, 479—482.

Hermance, J. F., Slocum, W. M., and Neumann, G. A.: 1984, 'The Long Valley/Mono Basin Volcanic Complex: A Preliminary Magnetotelluric and Magnetic Variation Interpretation', *J. Geoph. Res.* **89**, B10, 8.325—8.337.

Jiracek, G. R., Gustafson, E., and Mitchell, P. S.: 1983, 'Magnetotelluric Results Opposing Magma origin of Crustal Conductors in the Rio Grande Rift', *Tectonophysics* **94**, 299—326.

Jiracek, G. R., Rodi, W. L., and Vanyan, L. L.: 1987, 'Implications of Magnetotelluric Modelling for the Deep Crustal Environment in the Rio Grande Rift', *Phys. Earth Planet, Inter.* **45**, 179—192.

Keller, G. V., and Jacobson, J. J.: 1983, 'Deep Electromagnetic Soundings Northeast of the Geysers Steam Field', *Geothermal Resources Council Trans.* **7**, 491—502.

Keller, G. V., and Jacobson, J. J.: 1983, 'Megasource Electromagnetic Survey in the Bruneau-Grandview Area, Idaho', *Geothermal Resources Council Trans.* **7**, 505—510.

Keller, G. V.: 1986, 'Electrical Structure of the Crust and Outer Mantle Beneath the United States: Part 1, Methods for Determining the Conductivity Profile, Part 2, Survey of data'. (manuscript)

Keller, G. V.: 1987, 'Conductance Map of the United States', (Progress report), *Phys. Earth Planet. Inter.* **45**, 216—225.

Keshet, Y., and Hermance, J. F.: 1986, 'A New Regional Electrical Model for the Southern Section of the Rio Grande Rift and the Adjacent Basin and Range and Great Plains', *J. Geophys. Res.* **91**, B6, 6359—6366.

Long, C. L.: 1985, 'Regional Audiomagnetotelluric Study of the Questa Caldera, New Mexico', *J. Geoph. Res.* **90**: B13, 11.270—11.274.

MIT Field Geophysics Course (S. Park et al.): 1985, 'A Geophysical Study of Mesquite Valley: Nevada — California Boarder', *J. Geoph. Res.* **90**, B10, 8. 685—8.689.

Mitchell, P. S.: 1983, 'Deep Magnetotelluric Profiling of the Southern Albuquerque-Belen Basin, New Mexico', M.S. Thesis, San Diego State Univ., San Diego, Calif.

Mozley, E. C.: 1982, 'An Investigation of the Conductivity Distribution in the Vicinity of Cascade Volcano', Ph. D. Thesis, Univ. Calif., Berkeley, 385 pp.

Pedersen, J. and Hermance, J. F.: 1981, 'Deep Electrical Structure of the Colorado Plateau as Determined from Magnetotelluric Measurements', *J. Geoph. Res.* **86**, 1.849—1.857.

Prugger, A. F., and Woods, D. V.: 1984, 'The Pattern of Anomalous Geomagnetic Variations Fields over the Midcontinent Gravity High', *J. Geoph. Res.* **89**, B9, 7.773—7.782.

Ricard, Y., Froidevaux, C., and Hermance, J. F.: 1983, 'Model Heat Flow and Magnetotellurics for the San Andreas and Oceanic Transform Faults', *Ann. Geophysicae* **1**, 47—52.

Stanley, W. D.: 1982, 'A Regional Magnetotelluric Survey of the Cascades Mountains Region', U.S. Geol. Survey, Open File Report, 82—126.

Stanley, W. D.: 1982, 'Magnetotelluric Soundings on the Idaho National Engineering Laboratory Facility, Idaho', *J. Geoph. Res.* **87**, 2.683—2.691.

Stanley, W. D.: 1984, 'Tectonic Study of Cascade Range and Columbia Plateau in Washington State Based Upon Magnetotelluric Sounding', *J. Geoph. Res.* **89**, B6, 4.447—4.460.

Thomson, B. G., Nekut, A., and Kuckes, A. F.: 1983, 'A Deep Crustal Electromagnetic Sounding in the Georgia Piedmont', *J. Geophys. Res* **88**, B11, 9461—9473.

Wannamaker, P. E.: 1983, 'Resistivity Structure of the Northern Basin and Range', Geothermal Resources Council, Spec. Report No. 13, 345—362.

Wilt, M., Goldstein, N. E., Stark, M., Haught, J. R., and Morrison, H. F.: 1983, 'Experience with the EM-60 Electromagnetic System for Geothermal Exploration in Nevada, *Geophyscis* **48**, 1090—1101.

Young, P. D., and Cox, S. C.: 1981, 'Electromagnetic Active Source Sounding near the East Pacific Rise', *Geophys. Res. Lett.* **8**, 1043—1046.

E. EARLIER REVIEWS AND PAPERS OF GENERAL INTEREST

Ádám, A.: 1980, 'Relation of Mantle Conductivity to Physical Conditions within the Asthenosphere', *Geoph. Surveys* **4**, 43—55.

Alabi, A. O.: 1983, 'Magnetometer Array Studies', *Geoph. Surveys* **6**, 153—172.

Campbell, W. H., and Schiffmacher, E. R.: 1986, 'A Comparison of Upper Mantle Subcontinental Electric Conductivity for North America, Europe and Asia', *J. Geophysics* **59**, 56—61.

Cox, C. S.: 1981, 'On the Electrical Conductivity of the Oceanic Lithosphere', *Phys. Earth Planet. Inter.* **25**, 196—201.

Edwards, R. N.: 1977, 'Electromagnetic Methods for the Mapping of Regional Crustal Conductivity Anomalies', *Acta Geod. Geoph. et Montan. Hung.* **11**, 399—425.

Edwards, R. N., Bailey, R. C., and Garland, G. D.: 1981, 'Conductivity Anomalies: Lower Crust or Asthenosphere?', *Phys. Earth Planet. Inter.* **25**, 263—272.

Fournier, H.: 1980, 'Recent Work in Magnetotelluric Soundings of the Lower Crust and Uppermost Mantle', *Geoph. Surveys* **4**, 89—96.

Gough, D. I.: 1983, 'Electromagnetic Geophysics and Global Tectonics', *J. Geoph. Res.* **88**, B4, 3367—3377.

Gough, D. I., and Ingham, M. R.: 1983, 'Interpretation Methods for Magnetometer Arrays', *Rev. Geophys. Spce Phys.* **21**, 805—827.

Haak, V., and Hutton, R.: 1985, 'Electrical Resistivity in Continental Lower Crust', J. Geol. Soc. London.

Hermance, J. F.: 1983, 'Electromagnetic Induction Studies', *Rev. Geophys. Space Phys.* **21**, 652—665.
Jones, A. G.: 1981, 'On a Type Classification of Lower Crustal Layers under Precambrian Regions', *J. Geophys.* **49**, 226—233.
Jones, A. G.: 1983, 'The Problem of Current Channeling: A Critical Review', *Geophys. Surveys* **6**, 57—69.
Kaikkonen, P.: 1986, 'Numerical Electromagnetic Modeling Including Studies of Characteristic Dimensions: A Review', *Surveys in Geophysics* **8**, 301—337.
Keller, G. V.: 1982, 'Electrical Properties of Rocks and Minerals', in Carmichael, R. S. (ed.), Handbook of Physical Properties of Rocks, Vol. 1. CRC Press, Boca Raton, Fla. USA, pp. 217—272.
Roy, K. K., and Ghose, R.: 1985, 'Magnetotelluric and Seismic Evidences for Crust-Mantle Heterogeneities', *Phys. Earth Planet. Inter.* **41**, 143—153.
Strangway, D. S.: 1984, 'The Audiofrequency Magnetotelluric (AMT) Sounding', in Fitch (ed.), Meth. Explor. Geophys., Vol. 5.
Vanyan, L. L., and Cox, S. C.: 1983, 'Comparison of Deep Conductivities Beneath Continents and Oceans', *J. Geomag. Geoelectr.* **35**, 805—809.
Ward, S. H.: 1983, 'Controlled Source Electrical Methods for Deep Exploration', *Geophys. Surveys* **6**, 137—152.

F. BOOKS

Alperovich, I. M., Busnov, V. P., Varlamov, D. A., Konnov, Yu. K., Konovalov, Yu. F., Koschlakov, G. V., Chernyaskii, G. A., Skeinkman, A. L., and Yakovlev, I. A.: 1982, 'Magnetotellurics in Oil Exploration in the U.S.S.R.', English translation by G. V. Keller, editors: K. Vozoff, M. Asten. SEG (Soc. Explor. Geophysicists), Tulsa, OK, 65 pp.
Berdichevsky, M. N., and Zhdanov, M. S.: 1985, 'Advanced Theory of Deep Magnetotelluric Sounding', Elsevier, Amsterdam-Oxford-New York-Tokyo, 408 pp.
Kaufmann, A., and Keller, G. V.: 1981, 'The Magnetotelluric Sounding Method', Elsevier, Amsterdam-Oxford-New York, 591 pp.
Kaufmann, A., and Keller, G. V.: 1983, 'Frequency and Transient Soundings', Elsevier, Amsterdam-Oxford-New York, 685 pp.
Kovtun, A. A.: 1980, 'Ispolzovanie estestvennogo elektromagnitnogo polja pri izutshenii elektroprovodnostii Zemli', (Study of the Earth's Electrical Conductivity by means of Natural Electromagnetic Field), Leningrad Univ. Press (Izd. Leningr. Univers.), Leningrad, 196 pp.
Patra, H. P., and Mallick, K.: 1980, 'Geosounding Principles, 2, Time-varying Geoelectric Soundings', Elsevier, Amsterdam-Oxford-New York, 419 pp.
Rokityansky, I. I.: 1982, 'Geoelectromagnetic Investigations of the Earth's Crust and Mantle', Springer-Verlag, Würzburg, 381 pp.
Vanyan, L. L., and Shilovsky, P. P.: 1983, 'Glubinnaja elektroprovodnost okeanov i kontinentov (Global Electrical Conductivity of Oceans and Continents), "Nauka", Moskva, 88 pp.
Vanyan, L. L., Debabov, A. S., and Judin, M. N.: 1984, 'Interpretatsija dannikh magnitotellurischeskikh zondirovanij neodnorodnij cred. (Interpretation of Magnetotelluric Soundings in Nonlayered Media), "Nedra", Moskva, 199 pp.
Vozoff, K.: 1986, 'Magnetotelluric Methods', SEG, Reprint series, No. 5, Tulsa, USA, 763 pp.
Zhamaletdinov, A. A., (ed.): 1984, 'Korovie anomalii elektroprovodnostii (Crustal Anomalies of the Electrical Conductivity), Collection of Articles', "Nauka", Leningrad, 160 pp.