

# THE COLLECTIVE REVIEW PAPERS PRESENTED AT THE 7TH IAGA WORKSHOP ON ELECTROMAGNETIC INDUCTION IN THE EARTH AND MOON

## Preface

The 7th Workshop of Working Group I-3 of the International Association of Geomagnetism and Aeronomy on Electromagnetic Induction in the Earth and Moon was held on the campus of the University of Ife in Ile-Ife, Nigeria, during August 15–22, 1984. This was the first of these biennial workshops to be held in the African continent – three of the earlier workshops (see Table I) had been held in Europe, two in North America, and one at the European/Asian border.

The high cost of transportation to Nigeria unfortunately impacted severely on the number of international participants that were able to attend. A total of 65 participants registered coming from four of the five continents and representing 14 countries. However, although this particular workshop was the least well-attended of all seven so far, this was certainly counter-balanced by the intimate surroundings and informal atmosphere that prevailed throughout which lead to many fruitful and rewarding discussions. The sponsors of the Workshop were the Nigerian Union of Planetary and Radio Sciences, the Nigerian Federal Ministry of Education, Science and Technology, the Nigerian Academy of Science, the University of Ife and some other Nigerian Universities, the International Union of Geodesy and Geophysics, and the International Association of Geomagnetism and Aeronomy. Also, financial support was received, and very much appreciated, from many oil companies operating in Nigeria.

The scientific programme was divided into six sessions, of which five were preceded by a review paper on the subject of that session. Unfortunately, one of these review papers could not be completed in time to meet the deadline for publication in this issue of *Surveys in Geophysics*. All invited review papers lasted 40 min, whereas the 46 contributed papers that were presented were allotted 20 min each. However, due to their being time available because of withdrawn contributions, this Workshop was most satisfactory in that each paper could be discussed in full by the audience. This volume continues the tradition started by the first Workshop in publishing the review papers in one single journal for easy reference. It is once again hoped that this issue will become an essential reference source not only for those involved in electromagnetic induction, but also for geophysicists in other disciplines. Table I lists the special journal issues devoted to the review papers presented at the previous workshops.

For the benefit of the general reader, and also for those in the geomagnetic community who were unfortunately unable to attend this particular Workshop, we

TABLE I  
Workshop locations and review paper journal issues

Year	Location	Review papers issue
1972	Edinburgh, U.K.	<i>Phys. Earth Planet. Inter.</i> <b>7</b> , 227–398
1974	Ottawa, Canada	<i>Phys. Earth Planet. Inter.</i> <b>10</b> , 201–322
1976	Sopron, Hungary	<i>Acta Geodaet. Geophys. et Mont.</i> <b>11</b> , 329–509
1978	Murneau, F.R.G.	<i>Geophys. Surveys</i> <b>4</b> , 5–185
1980	Istanbul, Turkey	<i>Geophys. Surveys</i> <b>4</b> , 335–508
1982	Victoria, Canada	<i>Geophys. Surveys</i> <b>6</b> , 1–213
1984	Ile-Ife, Nigeria	<i>Surveys in Geophys.</i> (this issue)

summarized below the highlights of each session, including brief mention of the content of each review paper.

Session I – *Electromagnetic Induction Risks in Oil Pipelines* – consisted of Campbell's review plus five contributed papers. This topic is certainly of paramount importance to countries with long pipelines beneath either the Equatorial electrojet or the Auroral electrojets, and accordingly this session was very appropriate and timely. The corrosion process occurring on pipelines due to currents induced within the earth that find an easy path along the pipe was shown to be a complex problem by Campbell because it is a function of so many source-field parameters, and certainly Campbell's review is an excellent collation of work on this subject. The contributed papers included studies by the Nigerian National Petroleum Company that showed that currents of up to 2 Amps were measured on their pipelines during geomagnetic storm periods, and German work on a gas pipeline in northern Bavaria concluded that a linear relationship exists between the pipe-to-soil potential and variations of the geomagnetic field.

Session II – *Localized Sources: Field Studies and Modelling Techniques* – began with Mareschal's review and continued with four contributed papers with three other papers being withdrawn. This review paper provides an excellent bridge between those who consider the earth one-dimensional (1D) and magnetospheric sources three-dimensional (3D), and those who consider that the sources are uniform over a multi-dimensional earth. Certainly this work will become a standard reference for those in either field of geomagnetism. This session was one of those highlighted by intense debate concerning fundamental aspects of electromagnetic induction following one of the contributed papers.

Session III – *Induction Studies in Continental Regions, Including AMT Prospecting for Natural Resources* – was a full and active session comprising of Dupis' review paper (not in this issue) and 18 contributed papers. In his review, Dupis gave equal consideration to three topics; VLF techniques, controlled-source EM and MT, and provided a useful bibliography. The contributed papers could be subdivided into three main groups; (a) new field and data analysis techniques (5 papers); (b) modelling and interpretation (3 papers); and (c) structural studies of geological and tectonic interest (10 papers). The presence of a lower crustal conducting layer now

appears to be a virtually ubiquitous feature of most interpretations, but unfortunately its coincidence with strong seismic reflection horizons is not drawing the attention of the general geophysical and geological community to the potential of EM induction techniques.

Session IV – *Numerical Modelling including Studies of Characteristic Dimensions* – with its review paper and ten contributed papers with two withdrawals was also marked by fruitful and rewarding discussion following many papers. Kaikkonen's review considered in detail the technical aspects of two-dimensional (2D) and three-dimensional (3D) programmes currently in use. Kaikkonen introduced a theme that was repeated in many of the talks in this session – the absolute necessity for more precise phase determination. The breadth of this session was evident from the fact that papers were presented on 1D, 2D, and 3D problems. The solutions that were presented ranged from fully rigorous to fast approximations that are valid within certain limits, and new interpretative techniques were also given.

Session V – *Global Induction and Reference Electrical Earth Model* – of a review and nine contributed papers was one that addressed a current controversy in the induction community. Some geomagneticians wish to follow the lead of the seismologists and present a 'Reference Electrical Earth Model', whereas others feel that the earth must be too inhomogeneous laterally for such a model to have any meaning. The excellent review by Roberts considered very long periods (few hours to hundreds of days) and illustrated that even at such long periods the data from many magnetic observatories must be rejected from any 'global' analysis due to lateral inhomogeneities, principally the coast-effect. Roberts believes that there is sufficient evidence for a rapid increase in conductivity between 400 and 800 km, in contrast to the smoother variation produced by other workers. The varied contributed papers also dealt with deep earth structure, and even lower mantle conductivity from analysis of the 1969 jerk in secular acceleration.

Session VI – *ELAS: Summary of Results* – was intended to draw contributions dealing with the ELAS (for ELectrical ASthenosphere) project, but it became a discussion forum without any formal papers. A report was given on the recently formed Inter-Association Working Group on ELAS, and its standing in the IUGG. Various participants of the Workshop gave informal presentations concerned with various aspects of ELAS, and suggestions were made for future work.

The closing session included the Summarizer reports from each of the six scientific sessions, and formal acceptance of Dr Gaston Fischer's kind offer to hold the 8th Workshop in Neuchâtel, Switzerland, during August, 1986.

The very rewarding scientific component of the Workshop was balanced by a full and exciting social programme that was enjoyed by all. The Reception and Workshop Dinner were sponsored by Gulf Oil Company and Elf Nigeria Limited respectively, and were very opportune occasions for discussing ideas with participants from industry. A cultural play, a film, sight-seeing in Ile-Ife (the cradle of the Yorubas), and an excursion all maintained the informal and productive atmosphere of the Workshop. Finally, a two-day post-Workshop excursion to Kainji Lake National

Park was exciting, notwithstanding the long grass that hid most of the game.

In conclusion, it can be stated that the 7th Workshop on Electromagnetic Induction in the Earth and Moon was a resounding success, both scientifically and non-scientifically.

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