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Dear Jerry

BIBLIOGRAPHY OF GEOPHYSICAL TECHNIQUES IN CIVIL ENGINEERING

Many thanks for your letter of 3rd October enquiring after my progress on the bibliography. Well I have now completed a first draft and enclose two copies for your consideration. Perhaps you could pass a copy to Stan Ward.

I am not sure if this is what you were expecting, and so I won't be too surprised if you have plenty of comments. I look forward to these, and if your reaction is positive, some details of where we go from here.

Best regards

Dr Brian W Darracott

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**GEOPHYSICAL TECHNIQUES IN  
CIVIL ENGINEERING**

**A SELECTED BIBLIOGRAPHY**

**Compiled and edited by**

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## FOREWORD

During the last four decades the geophysical exploration industry in the non-communist world has grown rapidly to its present estimated annual expenditure of some US \$3600 million. Although by far the bulk of this effort is concerned with the petroleum and mining industries, there has, nevertheless, been a steady growth in the application of various geophysical techniques to civil engineering and ground-water studies, so that in 1983 the total expenditure in the free world in this area was around US \$34 million. (I have taken these figures from the S.E.G.'s Report of Geophysical Activity in 1983, compiled by Russel Senti and published in "The Lending Edge", July 1984). From early applications, in the 1930's, of the seismic refraction method to determination of depth-to-bedrock, the subject has grown steadily so that today the practice of engineering geophysics probably encompasses a greater range of techniques applied to a greater range of problems than any other branch of geophysics. To a large extent the techniques and equipment of engineering geophysics have evolved from the other sectors, with the main differences relating to the relatively shallow depths of investigation required (rarely greater than 100 m) and the need for lightweight and rugged portable equipment. The wheel has almost turned full circle now, and techniques developed for particular engineering problems are now being adapted for use in oil exploration (e.g. the use of shear waves).

There is, however, one major difference between engineering applications of geophysics and the others: whereas petroleum and mining exploration geophysics are concerned with the detection and evaluation of an economic resource, engineering geophysics is concerned essentially with the assessment of the ground and its suitability to accept some man-made structure. Geophysics plays an important part in the engineering design process for projects as diverse as high rise buildings and major dams, to the disposal of nuclear and other toxic wastes. It is thus vitally important that both the engineering geophysicist and the engineer are more than usually aware of the applicability and limitations of the various methods. There is no doubt that geophysical techniques have not gained as wide an acceptance in the field of civil engineering as their potential would permit. I believe that the principal reason for this is lack of appropriate education.

In 1962, the April issue of "Geophysics" (Vol. 27, No. 2) was devoted to papers concerning engineering applications of geophysics. In his introductory article to that volume Charles Drake drew attention to the relatively few papers on engineering applications that had been published in "Geophysics" up to that time, and suggested that the S.E.G. form an engineering geophysics Section which would encourage the publication of papers on engineering geophysics. The S.E.G. does now have its Engineering and Groundwater Committee and annual meetings of the Society now feature regularly one or more sessions devoted to engineering applications.

As yet, however, few institutions run detailed courses on engineering geophysics, and there is still no single source to which a geophysicist, engineer, or engineering geologist can turn to, or consult, which will give a ready summary of the availability of published and unpublished material concerning the applications of geophysical techniques to civil engineering. Almost all the textbooks on geophysics are aimed at oil or mineral exploration, and the ever-growing number of texts on engineering geology and geotechnics only treat the subject of geophysics superficially; and more than twenty years after Drake's article, there is still only a

handful of papers on engineering geophysics appearing in "Geophysics" each year. However over the years as I became more and more involved in engineering geophysics I realised that there is a surprisingly large body of information relating to engineering geophysical methods and case histories, albeit scattered throughout dozens of different journals and house publications from all over the world, but most of it readily available. Initially for my own purposes, but later with possible publication in mind, I set about collecting as much of this material as possible. After careful scrutiny of each paper and article "discovered", I have compiled this Selected Bibliography of approximately 800 references, with each entry classified according to its primary subject area. Thus, once the engineer (or other party) has decided to at least consider the use of geophysical methods, he will be able more easily to find out about the subject matter himself before approaching the specialist geophysicist with his particular problem. Conversely, the practising geophysicist may often be confronted with an unusual application or problem and will be able to see quickly if there are previous case histories and studies to which he can refer.

It is my hope that this bibliography will prove as useful to my fellow engineering geophysicists as it has to me and I am grateful to the S.E.G. for the opportunity to publish it.

Brian W Darracott  
Maidenhead, U.K.  
October 1984

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## INTRODUCTION

A work of this nature cannot possibly claim to be a complete and up-to-the-minute collection of every article and paper ever printed concerning engineering geophysics. It is therefore important to explain the basis upon which I have selected the various references, and, perhaps equally importantly, to clarify what is not included.

### Scope of Engineering Geophysics

Broadly speaking, there are four principal objectives in the use of engineering geophysical methods:-

- (i) Geological investigation : geophysical methods have a major role to play in mapping stratigraphy, determining the thickness of superficial deposits and the depth to engineering rockhead; establishing weathering profiles; and the study of particular erosional and structural features (e.g. location of buried channels, faults, dykes, etc).
- (ii) Resources assessment : location of aquifers and determination of water quality; exploration of sand and gravel deposits, and rock for aggregate; identification of clay deposits.
- (iii) Detection of voids and buried artefacts : e.g. abandoned mineshafts, natural cavities; old foundations; pipelines; wrecks at sea, etc.
- (iv) Determination of engineering parameters such as dynamic elastic moduli needed to solve many soil-structure interaction problems; soil corrosivity for pipeline protection studies; rock rippability and rock quality.

References dealing with applications of geophysical techniques to the above fields have been considered, with the exception of the following:-

- Seismicity and earthquake dynamics. The whole field of earthquake seismology is a subject in itself and is fully treated in specialist texts and journals.
- Non-destructive testing of structures, except pile integrity testing which happens frequently to be performed by geophysicists using relatively standard equipment.
- Groundwater exploration and water resources evaluation, except where the paper deals with an aspect of groundwater that may affect an engineering project; or deals with an aspect of near surface geology that may be of wider interest. I justify this decision on the basis that there is already an excellent bibliography, compiled by Frits vander Leeden, which covers the field of groundwater as a whole (see Groundwater Section).
- Vibration monitoring in general, on the grounds that this is generally regarded as falling within the domain of either environmental science or structural engineering.

As far as the geophysical methods themselves are concerned I have included references only to those papers and articles which deal with the principles of practice and interpretation of the techniques which are generally used. Thus airborne methods, which are rarely used in engineering studies, are not covered except occasionally in the applications sections (e.g. airborne

resistivity for gravel prospecting). I have also chosen only those references which are relevant to the understanding and execution of relatively shallow engineering surveys. This rules out for example, much of what has been published on seismic reflection data processing and interpretation. However, the reader who feels I have been over-zealous in this selection can do no better than consult the "Cumulative Index of Geophysics" published by the S.E.G. as Vol 48, No 10A, October 1983 Supplement. This covers all issues of "Geophysics" from 1936 through 1982 and "Geophysical Prospecting" from 1953 through 1982.

#### Sources of References

For practical reasons I have restricted the references to those written in English, though this is not to belittle the work published in other languages. The reader is referred to the important contributions in French - particularly those published in "Geophysical Prospecting", and by the Laboratoires des Ponts et Chaussées France, and the Centre Recherches et d'Etudes du Bâtiment et des Travaux Publics, France, and also those in Japanese. Some of the Japanese journals dealing with geophysics and soil mechanics feature translations in English, though these are not always readily accessible to those in the West.

The principal sources have been geophysical, geological and engineering journals and periodicals; publications of official bodies such as national geological surveys and research institutes; text books; trade journals and news magazines; and conference proceedings.

A quick glance through this Bibliography will show that there is quite a range of English language journals and periodicals, from various countries around the world, which have at one time or another carried papers and articles concerning engineering geophysics. However, only a few of these regularly include relevant material and these are (with their place of publication):

- Bulletin of the Association of Engineering Geologists (U.S.A.)
- Bulletin of the International Association of Engineering Geology (W.Germany)
- Bulletin of the Australian Society of Exploration Geophysicists (Australia)
- Engineering Geology (Elsevier Scientific Publishing Co., Holland)
- Geoexploration (Elsevier Scientific Publishing Co., Holland)
- Geophysical Prospecting (European Association of Exploration Geophysicists, Holland)
- Geophysics (Society of Exploration Geophysicists, U.S.A.)
- Geotechnique (British Geotechnical Society, U.K.)
- Ground Engineering (Geo Publications Ltd, U.K.)
- Ground Water (National Water Well Association U.S.A.)
- The Hydrographic Journal (The Hydrographic Society, U.K.)
- Journal of Geotechnical Engineering (American Society of Civil Engineers. Formerly called Journal of the Geotechnical Engineering Division 1974 up to 1983, and prior to that, Journal of the Soil Mechanics and Foundation Division, of the ASCE; U.S.A.)
- Quarterly Journal of Engineering Geology (The Geological Society, U.K.)

These journals should be scanned regularly for new and up-to-date techniques and case histories.

Most of the major national and international conference proceedings have been included; however, the conference business has expanded rapidly in the last few years and many of the smaller events are just not well enough publicised to gain more than local attention. I have not included



"abstract only" publications such as are produced for the annual meetings of S.E.G., A.E.G. and E.A.E.G., nor academic dissertations and theses. The question of publications of government departments presented a difficult choice, since there is often only a thin line between readily available serial publications and departmental reports which although on "open file" are not well publicised. In the event, I have included all those known to me and which, in my opinion, contain relevant material that is not reproduced elsewhere.

Finally, in compiling these references, I came across only three other published bibliographies dealing with related material. These concerned resistivity techniques, ground water, and acoustic emission, and are listed in the relevant sections in this bibliography.

### Use of the Bibliography

The references have been classified according to the principal subject material - something not always obvious from the title alone. Thus a paper dealing with seismic refraction surveys at a dam site would be classified under "seismic refraction" if the author's principal object was to present a new interpretation procedure or novel field technique, for example, whereas if the paper dealt with standard seismic methods to particular dam site it would be classified under "dams and reservoirs". In other words, I have attempted to separate out those papers dealing with primarily a geophysical technique, from those dealing principally with an application of a technique to a geological problem or engineering investigation.

In searching for useful references, the reader will have to think laterally. If the reader's interest is in the applications of geophysical methods to the study of foundations of dams, he should consult the "foundations" section for general articles, "dams" for specific applications, and also "elastic moduli" and "rock properties" for particular detail if relevant.

The first section lists 20 or so textbooks and similar documents which deal with general principles of geophysics, and books on engineering geology or site investigation which have useful accounts of the role of geophysics in engineering investigation. Textbooks dealing with a particular and single topic will be found in the appropriate section.

In compiling the section on ground radar methods, I have to some extent gone against the above "rules" insofar as I have put almost all the references dealing with radar methods and applications together. My reasoning is that this is still a relatively new and unfamiliar method, even to many geophysicists, and I hope the collection will be more informative in this way.

Finally, a number of organisations and professional societies are known by various acronyms, and these appear frequently in these reference lists. These are:-

- AEG : Association of Engineering Geologists
- ASCE : American Society of Civil Engineers
- ASTM : American Society for Testing and Materials
- BSI : British Standards Institution
- EAGE : European Association of Exploration Geophysicists
- ICE : Institution of Civil Engineers



IAEG : International Association of Engineering Geology  
IEEE : Institute of Electrical and Electronic Engineers  
OI : Oceanology International and Electronic Engineers  
OTC : Offshore Technology Conference  
SEG : Society of Exploration Geophysicists  
TRRL : Transport and Road Research Laboratory

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