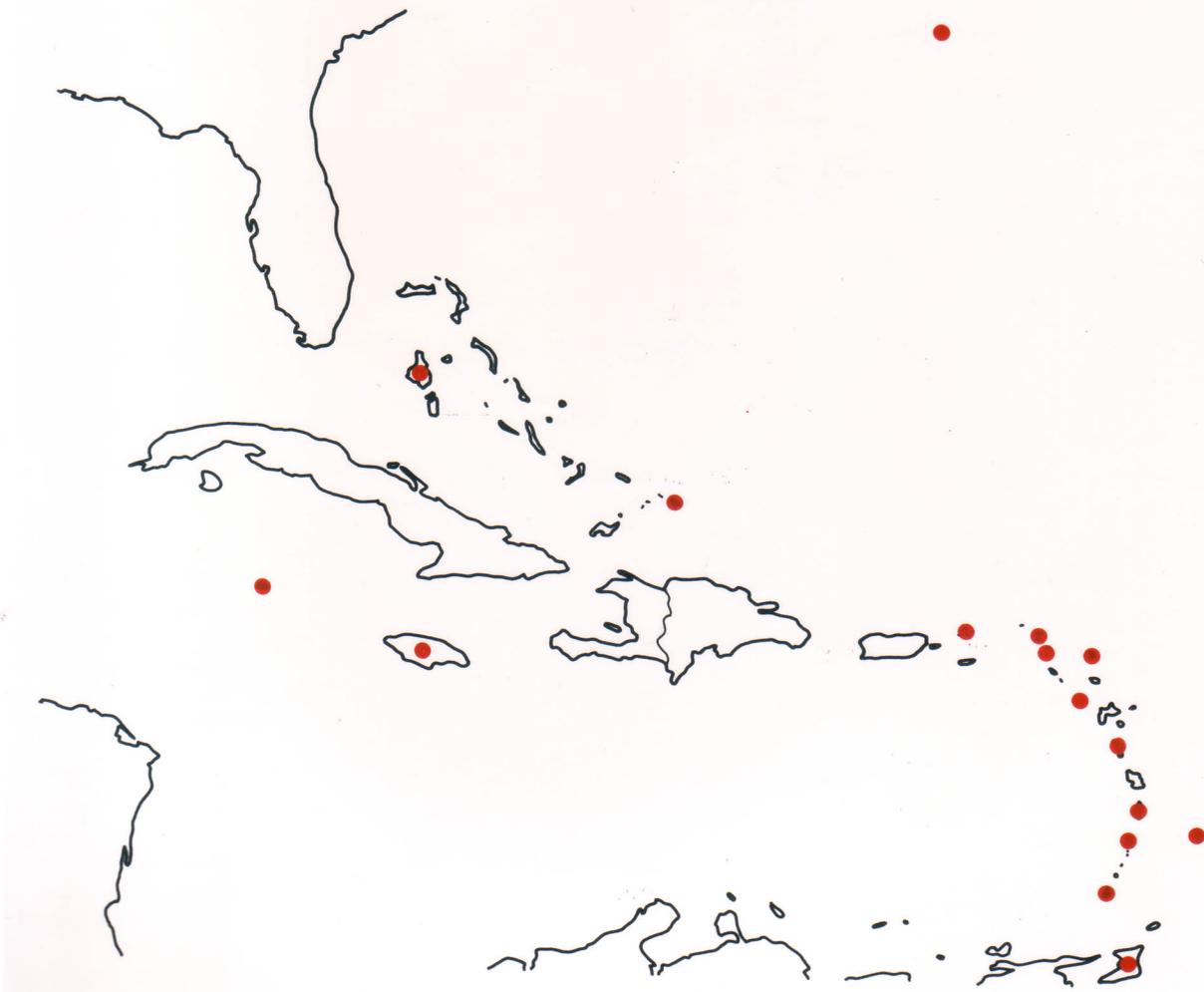


# BGS Technical Cooperation in the Caribbean (1965–90)



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British Geological Survey

Natural Environment Research Council

## Technical Report WC/91/31

International Geology Series

### BGS Technical Cooperation in the Caribbean (1965-90)

S J Mathers (Compiler)

International Division

*Cover illustration*

Top left, a typical Caribbean beach scene; Top right, drilling to investigate geothermal resources on St Lucia; Bottom, map of the Caribbean, red dots indicate locations of host countries.

*Bibliographic reference*

**British Geological Survey.** 1991. BGS Technical Cooperation in the Caribbean (1965-90). *British Geological Survey Technical Report WC/91/31.*

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## PROJECT LIST BY COUNTRY

COUNTRY	PROJECT NO.	TITLE	DATE
<b>ANGUILLA</b> 	10	UNESCO Hydrogeological Atlas	1986 – 1990
	12	Small Hydrogeological Studies	Various
<b>ANTIGUA &amp; BARBUDA</b> 	11	Construction Materials	1980
	12	Small Hydrogeological Studies	Various
<b>BAHAMAS</b> 	1	Hydrogeology of the Bahamian Islands	1969 – 1975
<b>BARBADOS</b> 	2	Geological Surveying of Barbados	1979 – 1980
	12	Small Hydrogeological Studies	Various
<b>BERMUDA</b> 	12	Small Hydrogeological Studies	Various
<b>BRITISH VIRGIN ISLANDS</b> 	10	UNESCO Hydrogeological Atlas	1986 – 1990
	11	Construction Materials	1980
	12	Small Hydrogeological Studies	Various
<b>CAYMAN ISLANDS</b> 	12	Small Hydrogeological Studies	Various
<b>DOMINICA</b> 	3	Dominica Minerals Study	1966
	4	Geotechnical Study of Freshwater Lake, Dominica	1981
	11	Construction Materials	1980
<b>GRENADA</b> 	10	UNESCO Hydrogeological Atlas	1986 – 1990

JAMAICA



5	Geological Surveying of Jamaica	1968 – 1973
6	Geochemical mapping of the CARICOM countries	1987 – On-going
7	Geophysical Investigations for Groundwater	1965 – 1966
12	Small Hydrogeological Studies	Various

MONTserrat



9	Geothermal Energy Studies	1974 – 1975
11	Construction Materials	1980

ST KITTS & NEVIS



10	UNESCO Hydrogeological Atlas	1986 – 1990
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ST LUCIA



9	Geothermal Energy Studies	1974 – 1975
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ST VINCENT & GRENADINES



10	UNESCO Hydrogeological Atlas	1986 – 1990
11	Construction Materials	1980
12	Small Hydrogeological Studies	Various

TRINIDAD & TOBAGO



8	Porcellanite Study, Trinidad	1968
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TURKS & CAICOS ISLANDS



10	UNESCO Hydrogeological Atlas	1986 – 1990
12	Small Hydrogeological Studies	Various

## Introduction

This report summarizes work undertaken by the British Geological Survey (BGS); formerly the Institute of Geological Sciences (IGS); in the Caribbean Basin during the period 1965 - 1990. The work was carried out as bilateral cooperation between the UK and the various host countries and was mainly funded by the Overseas Development Administration (ODA) as part of the UK overseas aid programme.

The politically fragmented nature of the Caribbean coupled with the small size of many of the constituent island nations means that the projects mounted were relatively small. The emphasis has naturally been towards countries which have historical links with Britain and those islands that still remain Crown Colonies. An index of the countries involved in the programme, together with details of their political status and the projects with which they were concerned, is given at the end of this report. Bermuda, which lies in the Atlantic Ocean off the coast of North America has been included in this review.

The work undertaken has comprised geological surveying, identification of mineral and energy resource potential and, in particular, assessment of water resources.

There are about 25 countries within the Caribbean Basin and some 16 of these, including Bermuda, have benefitted from cooperation with the BGS (and IGS) since 1965 (Fig.1). The work undertaken can conveniently be summarized in twelve individual projects, eight of which were country specific and four comprised regional initiatives involving several countries.

The information contained in this report is also stored in a BGS database of international activities.

## Review of Projects

The eight country-specific projects are as follows:-

### Bahamas

The hydrogeology of several of the Bahamian Islands was studied utilizing existing records, geophysics and drilling. Important lenses of usable freshwater were detected on each of the twelve islands studied; guidelines were developed for safe abstraction rates in order to avoid over-exploitation and the attendant problem of saline intrusion.

### Barbados

Geological Surveying of the Island of Barbados was accomplished at 1:10 000 scale; a new generalized geological map of the whole Island and a more detailed map of the complex Scotland District were published together with descriptions of the geology. During the survey materials that had potential use as industrial minerals were identified and preliminary "characterization" tests were performed enabling advice on potential applications to be provided.

### Dominica

The potential of the island of Dominica as a source of bauxite was investigated in 1966 taking advantage of fresh roadside cuttings produced by highway construction. Unfortunately no economic reserves were identified, the clay deposits proving suitable only for ceramic uses. Systematic sampling of stream sediments on the island was also carried out revealing several geochemical anomalies worthy of further investigation for metallic minerals.

A short consulting visit was made to Dominica in 1981 by an Engineering Geologist to assess the feasibility of upgrading the storage capacity of Freshwater Lake Reservoir. The study reported favourably on plans to develop the reservoir and recommended the types of specific work that would be required.

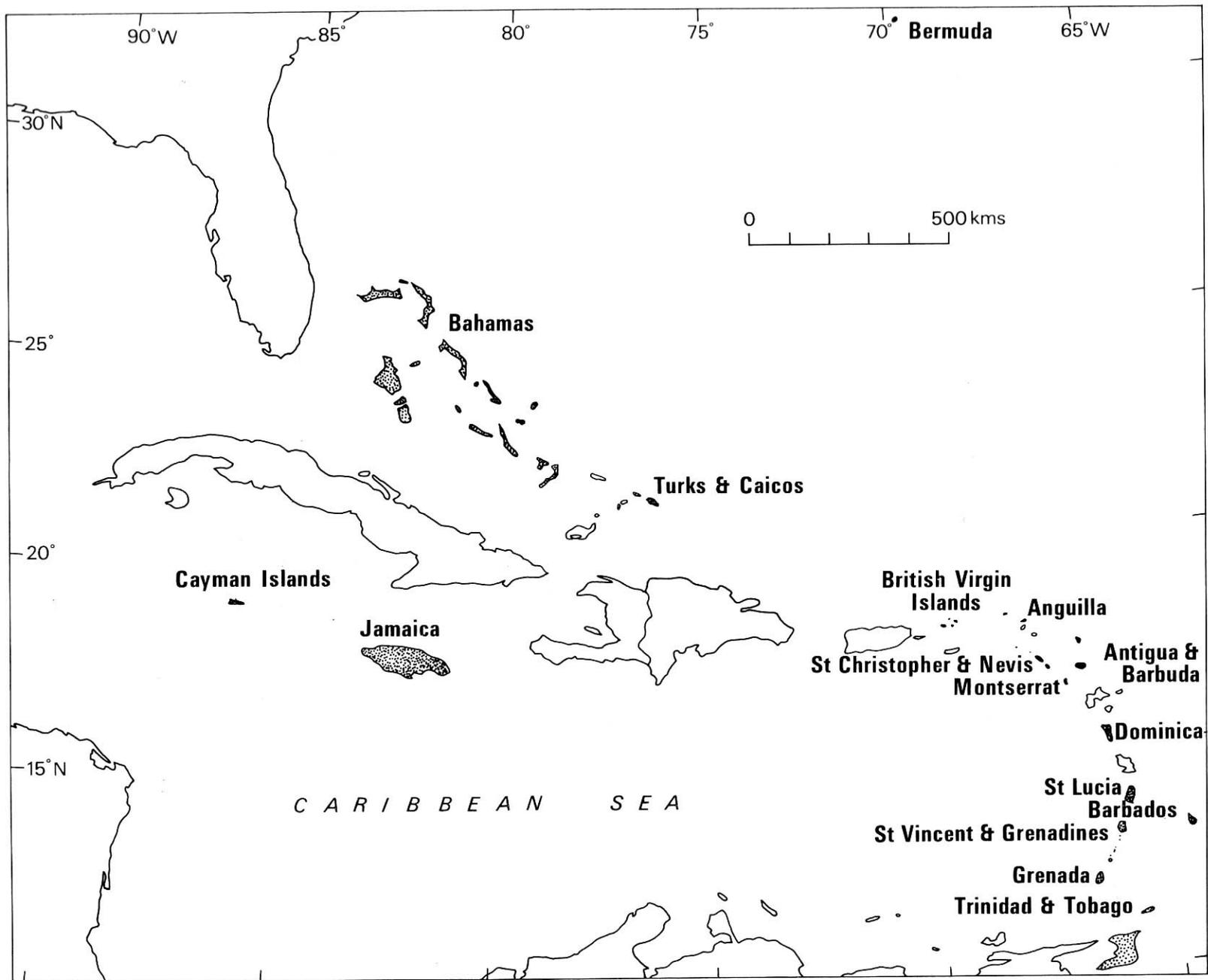


Figure 1. Map of the Caribbean Sea showing the locations of collaborating nations

## Jamaica

Geological surveying and interpretation of remotely sensed data were undertaken for selected parts of Jamaica, and a series of geological maps produced at 1:50 000 scale, covering much of the island, together with an inventory of the islands mineral resources. Special attention was paid to the urban geology and associated geotechnical problems of Kingston.

An on-going EC-funded regional study of geochemical mapping in the Caribbean has initially focused on gathering data in Jamaica. Geochemical anomalies suggesting potentially valuable deposits of gold and platinum have been identified and the chemical data also provide useful background information for the selection of sources of agrominerals. It is hoped to extend the studies throughout the CARICOM region with continued funding.

Seismic, resistivity and gravity surveys were undertaken in support of an UN-sponsored groundwater project in Jamaica. The seismic studies helped locate fault zones which have a high water yielding capacity.

## Trinidad and Tobago

Field and laboratory investigations were carried out on a porcellanite deposit in Trinidad with a view to its use as a pozzolan in cement manufacture. Extensive reserves were identified by the study and the laboratory tests revealed that 80% of the material satisfied the ASTM (American) specifications for this application.

The four studies which have involved more than one Caribbean nation are as follows:-

The geothermal energy potential of hot spring systems was investigated on St Lucia and Montserrat. The studies involved geological surveying, drilling, geophysics and geochemical analysis. Recommendations were made for continued exploration of the systems which were subsequently implemented by the UN.

BGS has recently completed a contribution to a United Nations Education and Science Council (UNESCO) hydrogeological atlas of the Caribbean. The atlas which is "in press" will include data provided by BGS in conjunction with the local authorities in six Caribbean countries, Anguilla, British Virgin Islands, Grenada, St Christopher & Nevis, St Vincent & Grenadines and the Turks and Caicos Islands.

Construction materials were the focus of an exploratory visit to several of the Windward and Leeward Islands in 1980. Advice on the suitability and quality of existing materials was provided whilst new sources of some materials were identified.

Numerous small hydrogeological studies concerned mainly with water supply and the problems of pollution and saline intrusion have been carried out. In addition to the studies in the Bahamas, described separately above, some nine other Caribbean nations have benefitted from these investigations over the last 25 years.

## NOTE ON PROJECT SIZE

On the Project Summary Forms the size of individual projects is given on a scale of 1 (very large) - 5 (small). Broad descriptions of these five categories are as follows

- Size 1 Large multidisciplinary studies carried out by sizeable residential teams with considerable specialist support; usually running for 5 - 10 years; making a major contribution to the development of geological knowledge and potential of the host country.
- Size 2 Important regional studies carried out by residential teams with specialist support usually upto 5 years in duration, making a significant contribution to geological knowledge of the host country.
- Size 3 Residential projects undertaken by 2 - 3 staff with some specialist support, generally about 3 years duration often concerned with particular themes or topics
- Size 4 Small projects on specific topics usually involving non-residential input from a small groups of specialists or an individual.
- Size 5 Short minor consultancies, training and advisory visits carried out by 1 - 2 staff usually with specific objectives.

**TITLE:** HYDROGEOLOGY OF BAHAMIAN ISLANDS

**LOCATIONS:** Bahamas

**PROJECT SIZE:** 4

**DATES:** 1969-75

**COLLABORATING ORGANISATIONS**

Land Resources Division ODA (LRD)  
Bahamas Ministry of Works, Public Works Department

**PROJECT OBJECTIVES**

Studies of Groundwater Resources on many Bahamian Islands  
(Abaco, Acklins, Andros, Cat, Crooked, Eleuthera, Grand Bahama, Great Exuma, Inagua, Little Exuma, Long, Mayaguana)

**PROJECT RESULTS**

Lenses of usable freshwater were detected by drilling and geophysics, on all the islands studied, guidelines have been developed for safe abstraction rates.

This was the first water resource evaluation of the Bahamian Islands and their freshwater lens reserves.

**OUTPUT (Reports, Papers, & etc)**

Land Resources of the Commonwealth of the Bahama Islands: (eight volumes) as follows

1970 Vol 1 Abaco  
1970 Vol 2 Eleuthera  
1972 Vol 3 Cat Island  
1973 Vol 4 Andros  
1975 Vol 5 Grand Bahama  
1975 Vol 6 Great Exuma, Little Exuma, Long Island  
1975 Vol 7 Crooked Island, Acklins  
1975 Vol 8 Mayaguana, Inagua

Little, B G, Buckley, D K, Cant, R, Young, R N. 1977. Land resources of the Bahamas: a summary. LRD publication 27. 133 pp.

**WORKSHOPS AND PRESENTATIONS****PROJECT STAFF**

D A Gray  
Dr J D Mather  
Dr D K Buckley

**FUNDING** ODA Technical Cooperation

<b>TITLE:</b> GEOLOGICAL SURVEYING OF BARBADOS	
<b>LOCATIONS:</b> Barbados	<b>PROJECT SIZE:</b> 4
	<b>DATES:</b> 1979-80
<b>COLLABORATING ORGANISATIONS</b> Ministry of Trade and Industry, Government of Barbados	
<b>PROJECT OBJECTIVES</b>  Geological surveying and the preparation of a new geological map of Barbados and a more detailed map of the complex Scotland District of the island.  Brief associated studies of mineral deposits of the island.	
<b>PROJECT RESULTS</b>  Geological studies enabled new geological maps of Barbados to be prepared together with a detailed map of the Scotland District. They were published by the Directorate of Overseas Surveys (DOS)  Various industrial minerals including clays and glass sand were tested and advice was given on their possible uses.	

**OUTPUT (Reports, Papers, & etc)**

## Maps

18 1:10 000 detailed geological maps covering the whole island (DOS 1227 dyeline series)

A 1:20 000 detailed geological map of the Scotland District Barbados, DOS 1982

A 1:50 000 geological map of Barbados with explanatory text, DOS 1983

## Reports

Barker, L H and Poole, E G. 1982. The geology and mineral assessment of the Island of Barbados. Report published by the Barbados Government.

Morgan, D J, Wilmot, R D and Bain, J A. 1980. Technical evaluation of clays from Barbados. IGS Applied Mineralogy Unit Report No 261.

**WORKSHOPS AND PRESENTATIONS****PROJECT STAFF**

E G Poole

**FUNDING** ODA Technical Cooperation

**TITLE:** DOMINICA MINERALS STUDY

**LOCATIONS:** Dominica

**PROJECT SIZE:** 4

**DATES:** 1966

**COLLABORATING ORGANISATIONS**

**PROJECT OBJECTIVES**

To examine and sample new road exposures on Dominica to investigate the possibility of Bauxite reserves.  
Systematic panning of Dominica's rivers for geochemical analysis.  
Investigation of Islands' mineral potential

**PROJECT RESULTS**

The results of chemical tests indicate that there is little prospect of finding commercial bauxite deposits in the accessible parts of the island. The clay deposits examined however could be suitable for use in ceramics.  
Several areas with anomalously high values of Cu, Pb and Zr have been detected which give hope that economic deposits of these minerals might be encountered by more detailed follow-up studies.  
Adequate reserves of accessible pumice are available to meet the long-term requirements for the lightweight aggregate industry in the Caribbean.

**OUTPUT (Reports, Papers, & etc)**

Dawson, J. 1966. Mineral Survey reconnaissance of Dominica, British West Indies. Institute of Geological Sciences. Overseas Division Report No 15.

**WORKSHOPS AND PRESENTATIONS**

**PROJECT STAFF**

J Dawson

**FUNDING** ODA Technical Cooperation

**TITLE:** GEOTECHNICAL STUDY OF FRESHWATER LAKE, DOMINICA

**LOCATIONS:** Dominica

**PROJECT SIZE:** 5

**DATES:** 1981

**COLLABORATING ORGANISATIONS**

**PROJECT OBJECTIVES**

The Dominican Electricity service and the Commonwealth Development Corporation planned to upgrade the storage capacity of Freshwater Lake for the Trafalgar Falls hydroelectric power station. A request to ODA was made for an engineering geologist to make a preliminary examination of the lake and surrounding area with the following terms of reference:

To examine the area around the existing lake which would be inundated by raising the water level 40 feet and assessing any problems which might arise.

To examine possible dam sites and assess the technical feasibility of constructing a dam of the required size and height having regard to existing foundation conditions;

If the construction of a dam to impound an additional 40 feet depth of water was not thought to be technically feasible to advise on the maximum height and location of a feasible dam (if any);

If the construction of the dam was thought to be technically feasible, drawing up terms of reference for any geological investigations required to prove the feasibility of construction and to allow consulting engineers to prepare designs for the project.

**PROJECT RESULTS**

This preliminary study confirmed that the main site is topographically suitable for dam construction, certainly up to 40' in height. An additional structure in the vicinity of the 'saddle' may also be required to prevent leakage towards the north west. Foundation conditions in both areas seem reasonable, but a further subsurface investigation will be required before alternative designs for the main structure can be finalised. The chief geological uncertainty of the reservoir site concerns seismic and volcanic activity, but this problem would need to be carefully investigated for any major civil engineering structure on the island.

**OUTPUT (Reports, Papers, & etc)**

Gostelow, T P. 1981. Geological study of Freshwater Lake, Dominica West Indies. IGS Report.

**WORKSHOPS AND PRESENTATIONS**

**PROJECT STAFF**

T P Gostelow

**FUNDING** ODA Technical Cooperation

**TITLE:** GEOLOGICAL SURVEYING OF JAMAICA

**LOCATIONS:** Jamaica

**PROJECT SIZE:** 3

**DATES:** 1968-73

**COLLABORATING ORGANISATIONS**

Geological Survey Department, Jamaica

**PROJECT OBJECTIVES**

Geological mapping and interpretation of remote sensing data of selected parts of Jamaica as a basis for the construction of tunnels for water supply and the development of mineral resources.

Production of a series of 1:50 000 geological maps covering the island.

Production of an inventory of the mineral resources of Jamaica as a guide for industry and government.

Detailed investigation of the geology of the urban area around the capital city Kingston.

**PROJECT RESULTS**

Geological mapping of the Blue Mountains and Kingston area was accomplished and detailed geological maps were produced.

Geological information was reviewed for the compilation of a series of 1:50 000 geological maps of Jamaica.

An inventory of mineral resources was published.

### **OUTPUT (Reports, Papers, & etc)**

Green, G W and Holliday, D W. 1970. The Cretaceous rocks of the Blue Mountain Peak, Jamaica. Journal Geological Society of Jamaica (Geonotes), 11, pp 19-23.

Holliday, D W. 1970. Field excursion to the Brooks and Bito gypsum quarries, eastern St Andrew. Journal Geological Society of Jamaica, Vol 11, 36-40.

Holliday, D W. 1971. Origin of Lower Eocene gypsum - anhydrite rocks. SE St Andrew, Jamaica. Transactions of the Institute of Mining and Metallurgy, Vol 80 B305-15.

Green, G W. 1972. The structure and stratigraphy of the Wagwater Belt in the vicinity of Kingston, Jamaica. Overseas Geology and Mineral Resources, No 48.

Black, C D G and Green, G W and Nawrocki, P E. 1972. Preliminary investigation of the Castleton copper prospect. Economic Geology Report, Geological Survey of Jamaica, 4, 26 pp JGS Pub 115.

Hughes, I G. 1973. The Mineral Resources of Jamaica. Bulletin Geological Survey of Jamaica, No 8, 89 pp.

Bateson, J H. 1973. Nomenclature of the Cretaceous rocks of the Central Inlier. Journal Geological Society of Jamaica Vol 13, 36-39.

Bateson, J H. 1974. Notes on the geology of the Bath area and their relationship to the Cretaceous rocks of the Blue Mountains. Journal Geological Society of Jamaica Vol 15, 22-30.

1:50 000 Geological Maps of Jamaica with explanatory text (20 Sheets,  $\frac{2}{3}$  island covered)

### **WORKSHOPS AND PRESENTATIONS**

6th Caribbean Geological Conference, Margarita, Venezuela 1971

### **PROJECT STAFF**

I G Hughes  
G W Green  
Dr D W Holliday  
J E G W Greenwood  
J H Bateson  
C R Cratchley  
Dr B Denness

**FUNDING** ODA Technical Cooperation

<b>TITLE:</b> GEOCHEMICAL MAPPING OF THE CARICOM COUNTRIES	
<b>LOCATIONS:</b> Jamaica (to-date)	<b>PROJECT SIZE:</b> 4
	<b>DATES:</b> 1987-On-going
<b>COLLABORATING ORGANISATIONS</b> Centre for Nuclear Sciences, University of West Indies	
<b>PROJECT OBJECTIVES</b> <p>To develop regional geochemical mapping methods in the Caribbean region appropriate for economic development, including agriculture and the minerals industry, environmental geochemistry and health. To work with local counterparts to develop this programme as an ongoing project based at the Centre for Nuclear Sciences, University of West Indies.</p>	
<b>PROJECT RESULTS</b> <p>Geochemical data gathered have helped pin-point potentially valuable deposits of gold and platinum in Jamaica and provide a database useful for the selection of agrominerals.</p> <p>The results to data are summarised in the seven publication and one confidential consultants report listed below.</p>	

## **OUTPUT (Reports, Papers, & etc)**

Simpson, P R, Hurdley, J and Plant, J A. 1988. Technical Assistance Geochemical Mapping Phase 1: Orientation Study and Training, Final Report on the Field Survey and Laboratory Studies University of the West Indies, Technical Assistance Contract.

Simpson, P R, Lalor, G C, Robotham, H, Hurdley, J, Milodowski, A E, Plant, J A and Smith, T K. 1988. New evidence of epithermal gold potential in andesitic volcanics of the Central Inlier, Jamaica. Transactions of the Institute of Mining and Metallurgy, B: 87, B88-91.

Lalor, G C, Miller, J, Robotham, H and Simpson, P R. 1989. Gamma radiometric survey of Jamaica. Transactions of the Institute of Mining and Metallurgy B: 98 B34-37.

Simpson, P R, Hurdley, J, Plant, J A, Lalor, G C and Robotham, H. 1989. Geochemistry for Agromineral Studies in the Caribbean Region. Abstracts, 28th International Geological Congress, Washington, DC USA, July 1989, 3-121.

Simpson, P R, Hurdley, J, Lalor, G C, Plant, J A, Robotham, H and Thompson, C. 1989. Orientation Studies in Jamaica for multipurpose geochemical mapping of the Caribbean Region. In Proceedings of IGCP 259, International Geochemical Mapping at the 28th International Geological Congress, Washington, DC USA, July 1989. Transactions of the Institute of Mining and Metallurgy.

Simpson, P R, Robotham, H and Hall, G E M. 1990. Regional Geochemical Orientation Studies for Platinum in Jamaica. Transactions of the Institute of Mining and Metallurgy. 183-187.

Simpson, P R, Lalor, G C, Robotham, H, Hurdley, J A and Plant, J A. 1991. Geochemical techniques for agromineral and related studies in Jamaica. In Geosciences in Development Proceedings of an international conference on the application of the geosciences in developing countries, Nottingham, September 1988, Stow, D A V and Laming D J C. eds., AGID Report Series No 14, Balkema, Rotterdam, 255-267.

Simpson, P R. In press. Orientation studies for Regional Geochemical Surveys in Jamaica. In Proceedings of Recent Advances in Caribbean Geology, an international conference to mark the 40th year of the University of the West Indies, Nov 1988. Journal of the Geological Society of Jamaica.

## **WORKSHOPS AND PRESENTATIONS**

Presentations at:

40th anniversary conference of University of West Indies 1988

Geosciences in Development, AGID, Nottingham 1988

28th International Geological Congress, Washington DC, USA 1989

## **PROJECT STAFF**

Dr P R Simpson

M Williams

J Hurdley

Dr J A Plant

**FUNDING** EC European Aid

<b>TITLE:</b> GEOPHYSICAL INVESTIGATIONS FOR GROUNDWATER	
<b>LOCATIONS:</b> Jamaica	<b>PROJECT SIZE:</b> 4
	<b>DATES:</b> 1965-6
<b>COLLABORATING ORGANISATIONS</b>	
<b>PROJECT OBJECTIVES</b>	
<p>Geophysical studies (seismic, resistivity and gravity) were required to assist in a UN-sponsored groundwater project in Jamaica.</p> <p>Three areas of interest were defined - the Pedro Plains, the Queen of Spain's Valley and the Moneague Basin.</p>	
<b>PROJECT RESULTS</b>	
<p>Detailed seismic, resistivity and gravity surveys were carried out at the three sites of interest.</p> <p>Seismic velocities were found to be very variable and their relation to the geology was unclear possibly suggesting that the seismic layers do not correspond to geological beds. Zones of faulting which can be expected to have a high water yield were detected.</p> <p>Low resistivities in the surface layers made the resistivity surveys of limited value and more sensitive instruments than those available would be required to assess the extent of saline intrusion in the areas studied.</p> <p>A single gravity profile failed to reveal the position of the zones of faulting indicated by the seismic studies and this approach was thus abandoned.</p>	

**OUTPUT (Reports, Papers, & etc)**

Andrew, E M and Greenwood, P G. 1966. Geophysical Investigations for UNSF FAO Groundwater Project, Jamaica. IGS Overseas Division Geophysical Report No.34. 14p.

**WORKSHOPS AND PRESENTATIONS**

**PROJECT STAFF**

E M Andrew  
P G Greenwood

**FUNDING** United Nations - Food and Agriculture Organisation

**TITLE:** PORCELLANITE STUDY, TRINIDAD

**LOCATIONS:** Trinidad and Tobago

**PROJECT SIZE:** 5

**DATES:** 1968

**COLLABORATING ORGANISATIONS**

Ministry of Petroleum and Mines, Trinidad and Tobago

**PROJECT OBJECTIVES**

Field and Laboratory Investigations of Porcellanite in Trinidad to determine its reserves and economic applications.

**PROJECT RESULTS**

Laboratory studies show the porcellanite, when finely ground, has excellent pozzolanic properties enabling its use in concretes which need good resistance to attack by acidic groundwater and seawater.

The field investigations, involving surveying, drilling and systematic sampling covered about 33% of the porcellanite body and proved extensive reserves of over 700 Million Tonnes.

Detailed follow-up tests show that over 80% of the porcellanite meets the ASTM (American) Standards for construction materials.

This should enable the production of pozzolanic cement at about half the cost of traditional 'Portland' cement.

**OUTPUT (Reports, Papers, & etc)**

Bristow, C R. 1969. Detailed Survey of Part of the Trinidad Porcellanite Deposits. IGS Overseas Division Report No 11. 63 p.

**WORKSHOPS AND PRESENTATIONS**

**PROJECT STAFF**

Dr C R Bristow

**FUNDING** ODA Technical Cooperation

<b>TITLE:</b> GEOTHERMAL ENERGY STUDIES	
<b>LOCATIONS:</b> Montserrat, St Lucia	<b>PROJECT SIZE:</b> 4
	<b>DATES:</b> 1974/5
<b>COLLABORATING ORGANISATIONS</b>	
Merz and McLellan Consulting Engineering Newcastle-upon-Tyne, UK (St Lucia Studies) University of the West Indies (Seismic Research Unit)	
<b>PROJECT OBJECTIVES</b>	
To investigate the possibility of using high enthalpy water and steam resources on St Lucia and Montserrat to provide steam for electric power.	
<b>PROJECT RESULTS</b>	
Geological surveying, exploratory drilling, geophysics and geochemical sampling of the geothermal hot springs on St Lucia and Montserrat was accomplished.	
Recommendations were made for continued exploration of the systems.	
Several deep wells were drilled in St Lucia; those that produced steam were tested for yield, reservoir conditions, water chemistry and gas composition.	
Further drilling by Italian consultants was funded by the UN, but BGS had no involvement in this later phase of development and the results are not known.	

## **OUTPUT (Reports, Papers, & etc)**

Morgan-Jones, M and Edmunds, W M. 1974. The Hydrochemistry of the Sulphur Springs. Soufriere, St Lucia IGS Report WD/74/6.

Buckley, D K. 1975. The St Lucia Geothermal Project. Interim Report Oct 1975. IGS Report WD/OS/75/9.

Williamson, K H. 1975. Preliminary report on geothermal well measurements; application to St Lucia Project IGS Report WD/OS/75/10.

Murray, K H. 1976. Report on the use of the Atlas Copco Craelius D75 drilling rig in Montserrat, W Indies. IGS Report WD/OS/76/11.

Merz and McLellan. 1976. Geothermal Prospect at Soufriere. Results of Exploratory Holes 1-5. Report for Govt. of St Lucia, under assignment from Min. of Overseas Dev., UK. (2 Vols)

Bath, A H. 1976. Investigations of quality of output from steam wells at Sulphur Springs, St Lucia, W Indies. IGS Report WD/OS/76/6.

Bath, A H and Edmunds, W M. 1976. The design, installation and operation of a steam-water cyclone separator for sampling at a steam-producing well in St Lucia, W Indies. IGS Report WD/OS/76/7.

Williamson, K H. 1976. Investigation of physical characteristics of output from steam wells at Sulphur Springs, St Lucia, W Indies. IGS Report WD/OS/76/9.

Williamson, K H. 1976. Steam production tests on geothermal wells at Sulphur Springs, St Lucia. IGS Report WD/OS/76/22.

Bath, A H. 1977. Summary of hydrochemical data for the geothermal area in Montserrat, W Indies. IGS Report WD/OS/77/2.

Williamson, K H and Wright, E P. 1977. St Lucia Geothermal Project in Proceedings of the Symposium on Geothermal Energy, Ankara, Turkey 1977, p.61-72.

Bath, A H. 1977. Chemical Interaction in a geothermal System in St Lucia, W Indies. Proceedings of 2nd International Symposium on Water-Rock Interaction. Strassbourg France.

Williamson, K H. 1979. A model for the Sulphur Springs, Geothermal Field, St Lucia. Geothermics Vol 8 p.75-83.

Williamson, K H. 1979. Tentative model for the Sulphur Springs, Geothermal System, St Lucia. IGS Report WD/OS/79/2.

## **WORKSHOPS AND PRESENTATIONS**

Geothermal Energy Seminar, St Lucia

Symposium on Geothermal Energy, Ankara, Turkey 1977

2nd International Symposium on Water-Rock Interaction, Strasbourg, France 1977.

**PROJECT STAFF**

Dr A H Bath  
Dr K H Williamson  
Dr E P Wright  
J H Bateson  
D R Giddings  
M Morgan-Jones  
Dr W M Edmunds  
D K Buckley  
K H Murray

**FUNDING** ODA Technical Cooperation

<b>TITLE:</b> UNESCO HYDROGEOLOGICAL ATLAS	
<b>LOCATIONS:</b> Anguilla, British Virgin Islands, Grenada, St Christopher & Nevis, St Vincent & Grenadines, Turks & Caicos Islands	<b>PROJECT SIZE:</b> 5  <b>DATES:</b> 1986-90
<b>COLLABORATING ORGANISATIONS</b>  United Nations Education and Science Council (UNESCO) Department of Water & Electricity, Anguilla Department of Water & Sewerage, British Virgin Islands Central Water Commission, Grenada Water Department & British Development Divisions, St Christopher & Nevis Central Water & Sewerage Authority, St Vincent & Grenadines Public Works Department, Turks and Caicos Islands	
<b>PROJECT OBJECTIVES</b>  Preparation of summary reports and maps on the Hydrogeology of six Caribbean Island Nations for inclusion in a forthcoming UNESCO Atlas.  The work involved reviewing existing documentation coupled with limited water sampling and testing to provide the information required for the atlas.	
<b>PROJECT RESULTS</b>  The objective was achieved satisfactorily and the documentation forwarded to UNESCO, the contribution has also been published as a BGS report. The UNESCO Atlas is scheduled for publication in 1993.	

### **OUTPUT (Reports, Papers, & etc)**

BGS 1988 Contributions to the UNESCO Hydrogeological Atlas of the Caribbean Islands. BGS Technical Report WD/88/30 (6 Volumes, as follows)

Volume 1 Turks and Caicos	by A C Cripps
2 British Virgin Islands	by G J Penn & N S Robins
3 Anguilla	by B Howarth & N S Robins
4 St Christopher & Nevis	by T B Kennedy & N S Robins
5 St Vincent & Grenadines	by D Cummings & A R Lawrence
6 Grenada	by W Ferguson & A R Lawrence

Robins, N S, Lawrence, A R and Cripps, A C. 1990. Problems of groundwater development in small volcanic islands in the eastern Caribbean. International Symposium on Tropical Hydrology and Fourth Caribbean Islands Water Resources Congress, AWRA. p 257-268.

### **WORKSHOPS AND PRESENTATIONS**

Workshop on the Hydrogeological Atlas of the Caribbean Islands. Santa Domingo 1986.

Workshop on the Hydrogeological Atlas of the Caribbean. Caracas, Venezuela 1988.

Tropical Hydrology and Caribbean Water Resources Conference. Puerto Rico 1990.

### **PROJECT STAFF**

A C Cripps  
Dr R A Downing  
N S Robins  
A R Lawrence

**FUNDING** ODA Technical Cooperation

<b>TITLE:</b> CONSTRUCTION MATERIALS	
<b>LOCATIONS:</b> Antigua & Barbuda, British Virgin Islands, Dominica, Montserrat, St Vincent & Grenadines	<b>PROJECT SIZE:</b> 5 <b>DATES:</b> 1980
<b>COLLABORATING ORGANISATIONS</b>	
<b>PROJECT OBJECTIVES</b> An advisory visit to several of the Windward and Leeward Islands in connection with materials for construction.	
<b>PROJECT RESULTS</b> Detailed field inspections enabled new sources of construction materials to be located on several islands, additionally some materials were identified as unsuitable. Advice on other uses for industrial minerals was given.  In Antigua a search failed to locate needed additional reserves of building sand. The Brick Clays being extracted were found to be bentonitic and advice was given on mitigating shrinkage problems on firing. Additional bentonite deposits were located. Barytes veins were located but proved uneconomic.  In the British Virgin Islands a source of good roadstone aggregate was located.  In Dominica brick and pottery clay, beach gravel and pumice were examined.  In Montserrat large supplies of uniform grade aggregate were located.  On St Vincent dry river deposits were found to be unsuitable for use as a pozzolan.	

**OUTPUT (Reports, Papers, & etc)**

**WORKSHOPS AND PRESENTATIONS**

**PROJECT STAFF**

E G Poole

**FUNDING** ODA Technical Cooperation

**TITLE:** SMALL HYDROGEOLOGICAL STUDIES

**LOCATIONS:** Anguilla, Antigua & Barbuda, Barbados, Bermuda, British Virgin Islands, Cayman Islands, Jamaica, St Vincent & Grenadines, Turks & Caicos Islands

**PROJECT SIZE:** 4/5

**DATES:** Various

**COLLABORATING ORGANISATIONS**

The Public Works and Health Departments of the various islands

**PROJECT OBJECTIVES**

Principally the objective of the studies was to identify new groundwater resources required by development of the region; this was carried out on many islands.

A principal problem that is encountered is that of saline intrusion from the sea making groundwater resources of low-lying coastal regions unsuitable for use. Such intrusion is commonly exacerbated in areas with a long history of groundwater extraction and careful studies are needed to advise on safe extraction ratios to avoid worsening the problem.

**PROJECT RESULTS**

1968 Brief Consulting visits to Jamaica, Barbados and Cayman Islands to advise on Ground-water Resources.

1969-71 Survey of Saline Intrusion in the Miocene Limestone Aquifer of Anguilla involving drilling and borehole logging.

Survey of Groundwater Resources in the Tertiary Limestone Aquifer of the Cayman Islands; proved resources sufficient for existing needs.

Survey of Groundwater Resources in Turks & Caicos Islands gave mixed results showing some to be islands without freshwater resources.

Survey of Barbuda identified extensive groundwater resources close to the capital Codrington.

Survey of Carriacou, St Vincent and Grenadines showed adequate groundwater resources are lacking.

Survey of Tortola, British Virgin Islands proved adequate long-term resources.

1982-5 Collaborative Studies with ODA-funded Water Engineer in Anguilla involving modelling of the freshwater lens of the island and the development of a coastal aquifer model by BGS.

1985 Study of pollution risks on Bermuda with local authorities, Recommendations made to maintain viable water resources.

**OUTPUT (Reports, Papers, & etc)**

Wright, E P. 1970. The Water Resources of Anguilla with particular reference to groundwater development. IGS Report WD/70/3.

Wright, E P. 1983. Anguilla Water Resources Study. BGS Technical Report WD/OS/83/1.

Lawrence, A R. 1983. The Groundwater Resources of St Helena. BGS Technical Report WD/OS/83/12.

Wright, E P. 1985. Hydrogeology and Groundwater Resources of Anguilla. BGS Technical Report WD/OS/85/28.

Barker, J A and Williams, A T. 1985. Experiences in modelling the freshwater lens of Anguilla BGS Technical Report WD/OS/85/26. Also Description of the model. BGS Technical Report WD/OS/85/27, and Review of hydrogeology. BGS Technical Report WD/OS/85/28.

Thomson, J A M and Foster, S S D. 1985. Groundwater Pollution Risks on Limestone Islands: An analysis of the Bermuda case. BGS Technical Report WD/OS/85/24.

Lawrence, A R. 1987. A review of the Groundwater Investigation Programme on St Helena. BGS Technical Report WD/OS/87/13.

Thomson, J A M and Foster, S S D. 1986. Effects of urbanisation on groundwater in limestone islands: an analysis of the Bermuda case. Journal Institute Water Engineers and Scientists 40, p 527-540.

**WORKSHOPS AND PRESENTATIONS**

Presentation at:

International Association of Hydrogeologists 21st Congress Guilim, China, 1988.

**PROJECT STAFF**

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**FUNDING** ODA Technical Cooperation