



BRITISH GEOLOGICAL SURVEY
International Division

BGS Technical Cooperation in Latin America (1965–90)



TECHNICAL REPORT WC/91/25

BGS Technical Cooperation in Latin America
(1965-90)

British Geological Survey
Natural Environment Research Council

Technical Report WC/91/25
International Geology Series

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International Division

Cover illustration

Top right, a BGS geologist studying molybdenum mineralization at an altitude of 4900 m in the Andes near Jacabamba, Peru; Bottom right, Peruvian counterpart geoscientists preparing geochemical samples in the Cordillera Blanca, central Peru; Left, map of Latin America, red dots indicate locations of host countries.

Bibliographic reference

British Geological Survey. 1991, BGS Technical Cooperation in Latin America (1965-90). *British Geological Survey Technical Report* WC191125.

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PROJECT LIST BY COUNTRY

COUNTRY	PROJECT NO.	TITLE	DATE
Argentina			
	1	Advisors to "Plan Patagonia"	1973
	2	Mineral Exploration in Chubut Province	1983
Belize			
	3	Geology of the Maya Mountains	1969-70
Bolivia			
	4	Regional Geology, Central Bolivia	1974-75
	5	Eastern Bolivia Mineral Exploration (Proyecto Precambrico)	1976-86
Brazil			
	6	Mineral Resources and Geological Advisors	1970-74
	36	The Manaus - Georgetown Hovercraft Expedition	1971
Chile			
	7	"Magellan Project", Southern Chile	1969-70
	8	Geological Advisors	1970-74
Colombia			
	9	Regional Geology, Valle, Southwest Colombia	1980-84
	10	Pacific Precious Metals Project	1986-90
Costa Rica			
	11	Talamanca Cordillera Regional Geology	1975-77
	12	Tilaran-Aguacate Gold Project	1981-83
	13	Valle Central Hydrogeology	1975-84 (Intermittent)
	14	Valle Central Groundwater Resources	1984-87
	15	Industrial Minerals Survey (PACOMI)	1987-91
Ecuador			
	16	Regional Geology, Loja & Llanganates	1969-70
	17	Regional Geology and Mineral Exploration	1972-80
	18	Geology of the Cordillera Real	1986-On going

Guyana



19	Regional Geology, Southern Guyana	1966-71
20	Geological Advisors	1973
36	The Manaus - Georgetown Hovercraft Expedition	1971

Honduras



21	Mosquitia Project	1981
22	Hydrogeology of Intermontane Basins	1982-84
23	Hydrogeological Advisors	1984-90
24	Geophysical study for minerals, Yuscaran	1986
25	Groundwater Investigation and Development	1988-95

Mexico



26	Volcanological Research and Training	1971-74
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Panama



27	Cerro Pando Geothermal Field	1977-81
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Peru



28	Geology of the Western Cordillera	1963-71
29	Coastal Batholith Research	1973-80
30	Mineral Exploration, Cordilleras Huayhuash and Blanca	1977-82
31	Geology of the Puno Region	1982-86
32	Groundwater Pollution and Recharge, Lima	1984-86
33	Geophysical Study, Ananea Gold Concession	1985
34	Peruvian Coal Studies	1984

Uruguay



35	Geophysical Survey of the Valentines Iron Deposits	1975
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Introduction

This report summarizes work undertaken in Mexico, the seven small republics of Central America and the 13 nations on the continent of South America by the British Geological Survey (BGS) formerly the Institute of Geological Sciences (IGS), during the period 1965 - 1990. Most of the work was carried out as bilateral technical co-operation with the British contribution funded by the Overseas Development Administration (ODA). Several small projects in which BGS served as consultants for international aid agencies and development banks are also included.

The BGS has made a significant contribution to geological surveying and mineral exploration in Latin America (Fig.1). The Andean countries of Bolivia, Colombia, Ecuador and Peru have in particular benefited from the cooperation with several regional surveys providing the geological framework for a total area about 2.5 times the size of Britain (Fig.2). Such projects identify economic potential worthy of the more detailed evaluations that are subsequently carried out by mining enterprises, oil companies and public service authorities.

Other substantial projects have included regional geological surveys in Belize and Guyana; mineral exploration in Chile, Colombia, Costa Rica and Peru; hydrogeological work in Costa Rica, Honduras and Peru and geothermal energy investigations in Panama.

In all the programme of 36 separate projects has involved 14 of the 21 Latin American countries. An index of projects and participating countries is provided at the end of the report. The information contained in this report is also stored in a BGS database of international activities.

Review of Projects

The 36 projects are summarized under the countries with which they were concerned.

Argentina

In 1973 four geologists provided training courses and advice to the Argentinian Government for an anticipated regional mineral exploration survey of Patagonia. In 1983 a small geophysical project assisted a United Nations investigation of the Huemules precious and base metal project helping to identify the extent of the ore-body.

Belize (formerly British Honduras)

A regional survey of the Maya Mountains in southern Belize enabled a detailed geological map and account of the geology of this area to be published. Synchronous geochemical sampling revealed limited potential although a promising area with high Molybdenum concentrations was identified and subsequently became the focus of exploration effort by a Canadian mining enterprise.

Bolivia

Regional geological surveying and mineral exploration of about a third of Bolivia was undertaken by BGS between 1974 - 1986 (Fig.2). The majority of the work was carried out in eastern Bolivia where some 250,000 km² of previously poorly known Precambrian shield terrain was surveyed and its mineral potential evaluated.

Geological maps, numerous scientific and economic articles and a comprehensive geochemical atlas of the region were published. The considerable mineral potential, which includes occurrences of gold, platinum, silver, uranium and rare earth elements was publicised at several international conferences. Follow-up exploration studies are being undertaken by multi-national companies including Rio Tinto Zinc. The success of this endeavour was highlighted by an ODA review of the project and an ODA sponsored conference in Bolivia in 1989 helped to attract interest from international mining companies.

Brazil

Between 1970 and 1974 assistance in assessing mineral resources in the states of Para and Piaui in northern Brazil was provided; a telemetered array of seismic stations was installed on the Brazilian Plateau and advice on the interpretation of radar images and the setting up of courses at the university of Bahia was given. In Piaui State new areas likely to contain diamonds and opal were identified and schemes for working these materials were devised. Northern Brazil was the starting point for a BBC hovercraft expedition to Georgetown, Guyana which included an IGS geologist as navigator.

Chile

A geochemical exploration programme in southern Chile - the Magellan Project - identified molybdenum, copper, nickel, lead and zinc anomalies worthy of follow-up exploration by mining enterprises. Subsequently resident advisors helped establish a geochemistry division in the Chilean Government's geological institute and provided hydrogeological advice in designing water supply schemes for copper processing in arid parts of northern Chile.

Colombia

During the 1980's regional geological surveying and mineral exploration was carried out in the departments of Cauca and Valle in southwest Colombia (Fig. 2). The surveys elucidated the geology of large segments of the Central and Western Cordilleras together with parts of the Pacific coastal plain. Porphyry-copper mineralization was discovered in the Central Cordillera whilst a fresh understanding of the origin and derivation of the alluvial gold deposits in the Western Cordillera and Pacific coastal plain should enable new occurrences to be found. A geochemical laboratory enabling analysis for a dozen key elements has been installed at INGEOMINAS - the counterpart organization - and on the job training and several scholarships have been provided to try to ensure that the work of these projects will continue with local endeavour.

Costa Rica

Five projects have been mounted in Costa Rica over the past 15 years, three concerned with mineral potential and two with hydrogeology.

Photogeological mapping and field reconnaissance enabled geological maps of part of the Talamanca Cordillera to be produced. The area is thought to have potential for porphyry-copper deposits because of the discovery of a large deposit within the Cordillera in neighbouring Panama.

The Tilaran-Aguacate mountains were the subject of a multidisciplinary study involving surveying, photogeology, geochemistry and geophysics which successfully provided advice on geochemical sampling methods and identified new targets for gold exploration.

The largest of the projects was the recently completed national industrial minerals survey. This 3 year project was divided into two phases. The first involved the compilation of a systematic inventory of known occurrences of industrial minerals together with an analysis of local markets and potential. The second phase followed with the detailed appraisal of economically valuable deposits of diatomite and high-purity limestone together with an exploration programme for bentonite. On the job training, seminars and study visits to the UK for counterpart staff were designed to ensure that the work continues successfully.

Two separate sources of funding enabled advice and technical support to be provided to the Costa Rican water authorities. Studies were focused on the densely populated Valle Central which includes the capital San Jose and other principal cities. Specific advice on the siting of production wells, safe abstraction rates and aquifer management was provided. A detailed study of the key Colima Aquifer was also undertaken with a view of its further development. It concluded that an additional wellfield could safely extract further water resources.

Ecuador

In the 1970's cooperation with Ecuador enabled some 40% of her national territory to be surveyed geologically and the mineral potential identified (Fig.2). The work covered most of the Ecuadorian Andes and the Pacific Coastal Plain. Geological maps have been produced for this entire region including more detailed editions for the major cities of Quito and Cuenca. The total area covered was approximately half the size of Britain. Important discoveries of copper and phosphate resources were made and geotechnical problems around the capital Quito was studied. Strengthening the national geological body DGGM (now INEMIN) involved the installation of a geochemical laboratory, training in cartography and field geology and the provision of 15 awards for counterpart staff to study in the UK.

An on-going study is seeking to elucidate the geology and mineral potential of the Cordillera Real in Eastern Ecuador, the area is believed to contain gold and base metal mineralization. Several areas with potential have been identified and these are the subject of current investigation.

Guyana (formerly British Guiana)

Between 1966 and 1971 the region south of latitude 4°N, which comprises more than a third of Guyana, was studied using photogeology and field traverses. The results were published as geological maps and accounts and include a comprehensive geological memoir on the area published in 1977. A subsequent short advisory visit helped establish a lapidary for the production of decorative stones and ornaments. The Manaus-Georgetown hovercraft expedition featured in a BBC documentary film terminated in Georgetown, Guyana.

Honduras

Four distinct projects have been carried out in Honduras. One concerned with regional development, two with hydrogeology and one involving geophysical studies for minerals.

The Mosquitia Project comprised an ODA-sponsored mission of experts to evaluate the natural and renewable resource potential of the Mosquitia part of Honduras. As part of this study a BGS geologist revised the geological framework of the area and made recommendations on the type of follow-up programme that would be necessary to establish the areas mineral potential.

Hydrogeological advice has been provided to the various national water organizations since 1982, initially by advisory visits and lately with the provision of two resident experts. Numerous hydrogeological projects and schemes have benefited from these arrangements including the improved provision of water to the capital city of Tegucigalpa.

A short geophysical study mainly comprising Induced Polarization measurements was undertaken for the United Nations at a mineral prospect they are helping to develop near Yuscaran in southern Honduras. The study pin-pointed targets for future UN drilling programmes.

Mexico

In the early 1970's IGS provided a resident expert at the National University in Mexico City to help train Mexican students in petrology and volcanology. The collaboration resulted in the publication of geological maps of the volcanoes Nevado de Toluca and Popocatepetl, together with the supervision of the theses of a dozen post-graduate students.

Panama

Multidisciplinary studies involving geological surveying, geophysics and geochemistry were carried out in order to assess the potential energy producing capacity of the Cerro Pando Geothermal Field in Panama. Recommendations were made to concentrate further exploration effort to the area farther north, the source of deep thermal waters.

Peru

Some sever projects have been mounted in collaboration with the Peruvian Government marking an almost continual input from 1963 to 1986.

Regional geological surveying and follow-up mineral exploration was conducted in the Pacific coastal part of Peru together with the Altiplano around Lake Titicaca comprising a combined area broadly the size of Britain (Fig.2). Important finds of copper and molybdenum mineralization were made during these studies. Additional advisory services in the fields of hydrogeology and engineering geology were also provided.

Another project studied possible problems of pollution that might result from recycling of wastewater in the drainage basin above the Peruvian capital city of Lima. The study identified pollutants including excessive nitrate concentrations and showed that the water recharging the aquifer was unsuitable for drinking.

In 1985 a short geophysical study was made for the United Nations on a gold concession at Ananea on the Altiplano near Lake Titicaca. The study helped elucidate the complex structure of gold bearing glacial moraines and enabled the cost-effective siting of boreholes subsequently drilled as part of the UN exploration effort.

In 1984 a BGS geologist undertook a brief review of the coal resources of Peru and made detailed recommendations for the studies necessary to develop the potential of this important sector.

Uruguay

In 1975 a short geophysical survey for the UN was conducted on the Valentines Iron ore-body in northeastern Uruguay. The survey revealed large magnetic anomalies related to the deposit which enabled its extent to be defined and helped guide a subsequent UN-funded exploratory drilling programme.



Figure 1. Map of Latin America showing the locations of collaborating nations

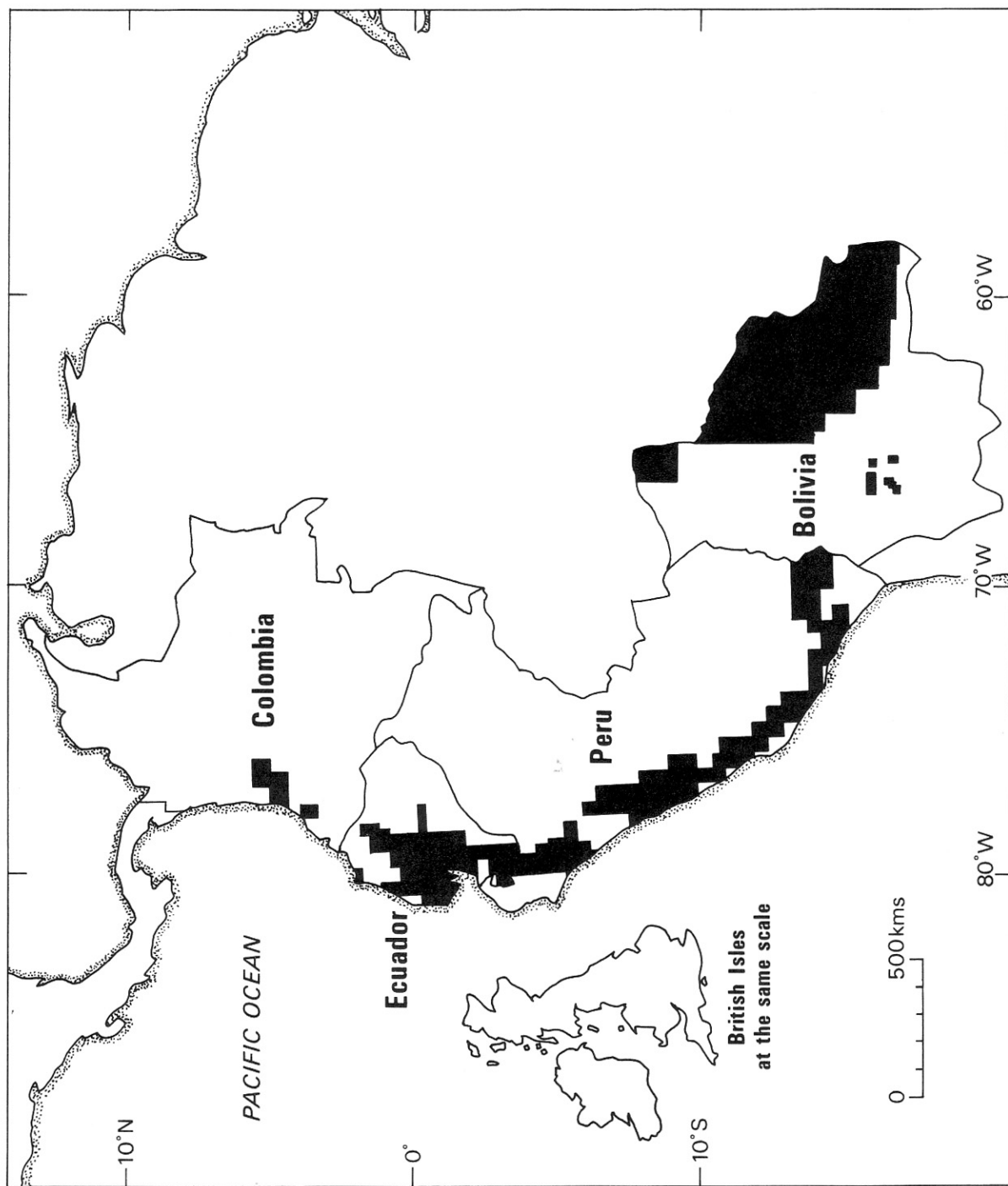


Figure 2. Areas covered by regional surveys involving BGS in Colombia, Ecuador, Peru and Bolivia.

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 nonresidential input from a small group of specialists or an individual. |
| Size 5 | Short minor consultancies, training and advisory visits carried out by 1 - 2 staff usually with specific objectives. |

ODA/BRITISH GEOLOGICAL SURVEY**FORM A3****PROJECT COMPLETION FORM****PROJECT NO: 1**

TITLE: ADVISORS TO "PLAN PATAGONIA"	
LOCATIONS: Argentina	PROJECT SIZE: 5 DATES: 1973
COLLABORATING ORGANISATIONS Ministerio de Industria y Minería, Argentina	
PROJECT OBJECTIVES The overall aim of Plan Patagonia was the geological survey and mineral exploration of southern Argentina (Argentinian Patagonia). The UK contribution was to assist in the design of the Plan by: <ul style="list-style-type: none">a) Providing consulting expertise in Geochemistry to design the mineral exploration strategy for Plan Patagoniab) Installing and training staff to operate an ODA donated Atomic Absorption Spectrophotometerc) Providing a short course in Photogeology	
PROJECT RESULTS The consultancies, courses and training were completed as planned contributing significantly to the strengthening of the 'Plan Patagonia' team's scientific capability.	
OUTPUT (Reports, Papers, & etc) Aucott, J W and Mezzetti, A. 1974. Geochemical and data preparation notes for Plan Patagonia Comahue. IGS Overseas Division Report.	

WORKSHOPS AND PRESENTATIONS

Photogeology Course

Training in the use of Atomic Absorption Spectrophotometer

PROJECT STAFF

Dr B G N Page

Dr J W Aucott

J L Roberts

Dr E J Cobbing

FUNDING ODA Technical Cooperation

ODA/BRITISH GEOLOGICAL SURVEY**FORM A3****PROJECT COMPLETION FORM****PROJECT NO: 2**

TITLE: MINERAL EXPLORATION IN CHUBUT PROVINCE	
LOCATIONS: Argentina	PROJECT SIZE: 5 DATES: 1983
COLLABORATING ORGANISATIONS	
PROJECT OBJECTIVES A Geophysicist contributed to the UNRFNRE study of the Huemules precious and base metal prospect in Chubut Province, Argentina.	
PROJECT RESULTS Included Polarization, Resistivity and Electromagnetic surveys were employed. The surveys helped define the structure of the long sulphide-bearing deposit and its transverse dislocations. Targets for detailed exploration were identified and recommendations made for the type of on-going investigation.	
OUTPUT (Reports, Papers, & etc) Confidential Report to UNRFNRE	
WORKSHOPS AND PRESENTATIONS	
PROJECT STAFF R B Evans	
FUNDING United Nations Revolving Fund for Natural Resources Exploration (JNRFNRE)	

TITLE: GEOLOGY OF THE MAYA MOUNTAINS

LOCATIONS: Belize

PROJECT SIZE: 3

DATES: 1969-70

COLLABORATING ORGANISATIONS

PROJECT OBJECTIVES

Remapping and Geochemical Prospecting of the Maya Mountains

PROJECT RESULTS

The 5200 km² area of the Maya Mountains in Belize has been remapped and its Economic Potential evaluated.

The Stratigraphy of the area has been completely revised.

Geochemical studies on the whole were disappointing with the exception of one area with high molybdenum values, this anomaly was followed up by a Canadian mining company.

OUTPUT (Reports, Papers, & etc)

Bateson, J H and Hall, I H S. 1970. Reconnaissance geochemical and geological investigation of the Maya Mountains of Southern British Honduras. IGS Overseas Division Report Series. Report No 16.

Kesler, S E and others. 1971. Mesoscopic structural homogeneity of the Maya Series, Mountain Pine Ridge, British Honduras. American Association of Petroleum Geologists, Bulletin, Vol 55 No 5 pp 97-103.

Bateson, J H and Hall, I H S. 1971. Revised geologic nomenclature for pre-Cretaceous rocks of British Honduras American Association of Petroleum Geologists, Bulletin, Vol 55 No 3 pp 529-530.

Bateson, J H. 1972. New interpretation of the geology of the Maya Mountains, British Honduras. American Association of Petroleum Geologists, Bulletin, Vol 56, No 5, pp 956-964.

Hall, I H S and Bateson, J H. 1972. Late Palaeozoic lavas in Maya Mountains, British Honduras, and their possible regional significance. American Association of Petroleum Geologists, Bulletin, Vol 56, pp 950-956.

Bateson, J H, with Kesler, S E and Kienle, C R. 1974. Tectonic significance of intrusive rocks in the Maya Mountains, British Honduras. Bulletin Geological Society America, Vol 85, pp 549-552.

Rouse, J, Snelling, N J and Bateson, J H. 1975. Age Determinations on Igneous rocks from the Maya Mountains, Belize. IGS Isotope Geology Unit Report No 75.

Bateson, J H and Hall, I H S. 1977. The Geology of the Maya Mountains, Belize. Overseas Memoir No 3. HMSO London 43p 1 Map.

WORKSHOPS AND PRESENTATIONS**PROJECT STAFF**

J H Bateson
I H S Hall
N J Snelling
J Rouse

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ODA/BRITISH GEOLOGICAL SURVEY**FORM A3****PROJECT COMPLETION FORM****PROJECT NO. 4**

TITLE: REGIONAL GEOLOGY, CENTRAL BOLIVIA	
LOCATIONS: Bolivia	PROJECT SIZE: 3 DATES: 1974-5
COLLABORATING ORGANISATIONS Servicio Geologico de Bolivia (GEOBOL) La Paz	
PROJECT OBJECTIVES Regional Photogeological Mapping in the sub-Andean belt of Bolivia south west of Santa Cruz (one-degree Square 18-19°S 64-65°W)	
PROJECT RESULTS The designated area was mapped by Photogeology and field checking; a 1:250 000 geological map and explanatory text of the area were produced.	
OUTPUT (Reports, Papers, & etc) 1:250 000 Geological map of the Vallegrande Region GEOBOL 1979	
WORKSHOPS AND PRESENTATIONS Informal presentation made to GEOBOL staff in La Paz at termination of fieldwork - main theme - the value of satellite imagery and interpretation in regional mapping.	
PROJECT STAFF J H Bateson P J Strange	
FUNDING ODA Technical Cooperation	

ODA/BRITISH GEOLOGICAL SURVEY**FORM A3****PROJECT COMPLETION FORM****PROJECT NO: 5****TITLE:** EASTERN BOLIVIA MINERAL EXPLORATION (PROYECTO PRECAMBRICO)**LOCATIONS:** Bolivia**PROJECT SIZE:** 1**DATES:** 1976-86

Phase 1 - 1976-9

Phase II - 1980-3

Phase III - 1983-6

COLLABORATING ORGANISATIONS

Servicio Geologico de Bolivia (GEOBOL), Santa Cruz

PROJECT OBJECTIVES

To conduct a major regional survey of the geology and mineral potential of the Precambrian Shield terrain of Eastern Bolivia. The area involved is about 250:000 km² (roughly the same size as Great Britain) much of which is remote and relatively inaccessible.

To publicise any Economic/Mineral Potential found within the region.

PROJECT RESULTS

Geological maps covering the entire region have been published.

A Geochemical Atlas showing the distribution of 22 elements has been published for the region as a guide to mineral exploration.

A substantial number of reports and scientific articles have been written and published by BGS and science journals.

The considerable mineral potential of the region identified by the project has been published at an ODA sponsored International Conference in Santa Cruz, Bolivia, 1989 generating exploration interest from major mining companies.

Potentially-economic occurrences of many metallic minerals have been detected; these include gold, platinum, silver, copper, lead, zinc, tin, rare earths, uranium and nickel together with a variety of industrial minerals.

An ODA review of the project concluded the project was a major success, quoting independent observers who believe it to be outstanding and the best geological study in Bolivia in the last 25 years.

OUTPUT (Reports, Papers, & etc)

Attached is a copy of a catalogue of documentary products from the Project compiled in 1986 at the end of Phase III of the project.

Subsequent output is listed below:-

Litherland, M, Annells, R N, Darbyshire, D P F, Fletcher, C J N, Hawkins, M P, Klinck, B A, Mitchell, W I, O'Connor, E A, Pitfield, P E J, Power, G and Webb, B C, 1989. The Proterozoic of Eastern Bolivia and its relationship to the Andean Mobile Belt. Precambrian Research Vol 43 157-174.

Fletcher, C J N and Beddoe-Stephens B. 1987. The Petrology and crystallization history of the Velasco Alkaline Province, eastern Bolivia in Alkaline Igneous Rocks Special Publication of the Geological Society of London No.30 p.403-13.

O'Connor, E A, Pitfield, P E J and Litherland, M. 1987. Landscape and Landsat over the eastern Bolivia Shield Zeitschrift für Geomorphologie Vol.64 p.97-109.

WORKSHOPS AND PRESENTATIONS

PROJECT STAFF

Dr K Bloomfield	(Project Manager 1976-9) Phase I	D P F Darbyshire	R B Evans
Dr J Berrange	(Project Manager 1980-3) Phase II	J A T Smellie	N Grant
C C J Burton	(Project Manager 1983-6) Phase III (Independent Consultant)	M T Styles	C Halls
Dr R N Annells		R R Harding	Dr B Beddoe-Stephens
Dr M Litherland	Dr C J N Fletcher	A G Gunn	
Dr J D Appleton	Dr W I Mitchell	N J Snelling	
Dr B A Klinck	Dr B C Webb	M Bennett	
Dr E A O'Connor	Dr G Power	A J Shaw	
P E J Pitfield	M P Hawkins	W I Mitchell	

FUNDING ODA Technical Cooperation

PROYECTO PRECAMBRICO

Catalogue of Documentary Products

Compiled by

C C J Burton, BSc., C. Eng.

Preface

The listings cover all the documentary products of 'Proyecto Precambrico' and are grouped into

- A. External Publications covering papers published in scientific journals and conference proceedings;
- B. Open-File Reports and Published Maps
- C. BGS Publications.

Copies of Open-File Reports may be obtained at reproduction and carriage costs from:

Information and Central Services Directorate
British Geological Survey
Keyworth
NG12 5GG
United Kingdom

Servicio Geologico de Bolivia
Casilla 2729
La Paz
Bolivia

or

Published Maps may also be obtained at cost from the above addresses.

BGS Publications may be obtained at cost from the above BGS address.

REFERENCES

Please note that because of the alphabetical rearrangement of the authorship of the report series in phases I and II the report numbers are incorrect. For future reference use the report numbers listed below.
P.E.J. PITFIELD

NUMBER REFERENCES

These refer to the final twenty-one reports covering Phase I and Phase II of the Project and listed below. The reports are on open file at BGS, Keyworth, and GEOBOL, La Paz, (in Spanish). Accompanying published maps may be purchased.

Phase I reports (1979):

1. Summary of the geology and mineral potential of the Project area—Southern Zone (two maps at 1:1 000 000), compiled by K. Bloomfield and M. Litherland.
2. The geology and mineral potential of the Concepción area (Quad. SE 20-3 with part of SE 20-2) (map at 1:250 000), compiled by C. J. N. Fletcher.
3. The geology and mineral potential of the San Ignacio de Velasco area (Part of Quad. SE 20-4) (map at 1:250 000), compiled by M. Litherland.
4. The geology and mineral potential of the Las Petas-San Matías area (Parts of Quads. SE 21-1 and SE 21-2) (map at 1:250 000), compiled by P. E. J. Pitfield.
5. The geology and mineral potential of the San José de Chiquitos area (Quad. SE 20-8 with part of SE 20-7) (map at 1:250 000), compiled by E. A. O'Connor.
6. The geology and mineral potential of the Santo Corazón-Rincón del Tigre area (Quads. SE 21-5 with part of SE 21-9, and SE 21-6 with part of SE 21-10) (two maps at 1:250 000), compiled by W. I. Mitchell.
7. The geology and mineral potential of the Rincón del Tigre Igneous Complex (map at 1:100 000), compiled by R. N. Annells.
8. The geology and mineral potential of the Velasco Alkaline Province and Cerro Manomó (three maps at 1:100 000 and four at 1:20 000), compiled by C. J. N. Fletcher.
9. Results of the age determination programme (map at 1:1 000 000), compiled by D. P. F. Darbyshire.

Phase II reports (1982):

10. The geology and mineral potential of the Huanchaca area (Parts of Quads. SD 20-12 and SD 20-8) (map at 1:250 000), compiled by M. Litherland.
11. The geology and mineral potential of the Perseverancia and Monte Verde areas (Quads. SD 20-11 and SD 20-15) (2 maps at 1:250 000), compiled by B. A. Klinck and E. A. O'Connor.
12. The geology and mineral potential of the Huachi and Ascensión de Guarayos areas (Parts of Quads. SD. 20-10 and SD 20-14) (2 maps at 1:250 000), compiled by R. N. Annells and M. P. Hawkins.
13. The geology and mineral potential of the Manomó area (Part of Quad. SD 20-16) (map at 1:250 000), compiled by M. P. Hawkins.
14. The geology and mineral potential of the Magdalena area (Parts of Quads. SD 20-6 and SD 20-2) (map at 1:250 000), compiled by P. E. J. Pitfield and G. Power.
15. The geology and mineral potential of the Puerto Villazón area (Parts of Quads. SD 20-7 and SD 20-3) (map at 1:250 000 and at 1:100 000), compiled by P. E. J. Pitfield.
16. Geochemical prospecting for base metals in the San José de

Chiquitos inlier (various maps), compiled by J. D. Appleton and A. Llanos.

17. Prospecting for tin in the Ascensión de Guarayos and Concepción areas (various maps), compiled by J. D. Appleton and A. Llanos.

18. Pegmatites, quartz veins and quartz breccia reefs in the Precambrian shield of eastern Bolivia (map at 1:500 000), compiled by J. D. Appleton, C. C. J. Burton and A. Llanos.

19. The geology and mineral resources of Cerro Manomó (6 maps at 1:10 000), compiled by C. C. J. Burton.

20. The mineral resources of the Rincón del Tigre Igneous Complex (various map), compiled by R. N. Annells and C. C. J. Burton.

21. Synopsis of the geology and mineral potential of the Proyecto Precámbrico area—Southern and Northern Zones (2 maps at 1:1 000 000), compiled by J. P. Berrangé and M. Litherland.

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AHLFELD, F. 1954. *Los yacimientos minerales de Bolivia*. 277pp. (La Paz: Banco Minero de Bolivia y Corporación Minera de Bolivia.)

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ALMEIDA, F. F. M. DE. 1964. Geología do Centro-Oeste Matogrossense. *Bol. Div. Geol. Min., Dep. Nac. Prod. Min., Rio de Janeiro*, No. 215, 1–37.

— 1983. Relações tectônicas das rochas alcalinas Mesozóicas da região meridional da Plataforma Sul-Americana. *Rev. Bras. Geociências*, Vol. 13, No. 3, 139–158.

— HASUI, Y. and BRITO NEVES, B. B. DE. 1976. The Upper Precambrian of South America. *Bol. Inst. Geociências Univ. São Paulo*, Vol. 7, 45–80.

— — — and FUCK, R. A. 1981. Brazilian structural provinces: an introduction. *Earth-Sci. Rev.*, Vol. 17, 1–29.

— — 1984. *O Pré-Cambriano do Brasil*. 378pp. (São Paulo: Edgard Blücher.)

ANNELLS, R. N. and APPLETON, J. D. 1983. Occurrence of lateritic nickel mineralisation at Rincón del Tigre, eastern Bolivia. *Trans. Inst. Min. Metall.*, Vol. 92, B46–48.

— — and FLETCHER C. J. N. *In press a*. A major ultramafic-mafic layered intrusion of Proterozoic age: The Rincón del Tigre Igneous Complex, eastern Bolivia. *Proc. 4th. Latin American Geol. Congr., Port of Spain, Trinidad and Tobago, July 1979*.

— — — Burton, C. C. J., Evans, R. B., Styles, M. T., and HARDING, R. R. *In press b*. Mineral potential of the Rincón del Tigre Igneous Complex: a major Upper Proterozoic layered intrusion in the shield of Eastern Bolivia. In volume of Proceedings, 'Metallageny of basic and ultrabasic rocks', Institution of Mining and Metallurgy, Edinburgh, April 1985.

— — — — — *In press c*. The Rincón del Tigre Igneous Complex: a layered ultramafic-mafic intrusion of Upper Proterozoic age in the Precambrian Shield of eastern Bolivia. Part 1:

B. Open File reports and published maps

Project reports, published and on open file at the libraries of the British Geological Survey, Keyworth, Nottingham, UK. Also available for inspection at the offices of the Servicio Geologico de Bolivia (GEOBOL), Santa Cruz, La Paz, Bolivia.

For location see map.

Phase 1 1976-1979

1. Annells, R.N. et. al, 1979. The geology and mineral potential of the Rincon del Tigre Igneous Complex. Map at 1:100,000.
2. Bloomfield, K. and Litherland, M., 1979. Summary of the geology and mineral potential of the Project area - Southern Zone. 2 Maps at 1:1,000,000.
3. Darbyshire, D.P.F. 1979. Results of the age determination programme.
4. Fletcher, C.J.N. et. al. 1979. The geology and mineral potential of the Concepcion area. Map at 1:250,000.
5. Fletcher, C.J.N. et. al. 1979. The geology and mineral potential of the Velasco Alkaline Province and Cerro Manomo. Map at 1:100,000.
6. Litherland, M. et. al. 1979. The geology and mineral potential of the San Ignacio de Velasco area. Map at 1:250,000.
7. Mitchell, W.I. et. al, 1979. The geology and mineral potential of the Santo Corazon - Rincon del Tigre area. Map at 1:250,000.
8. Pitfield, P.E.J. et. al. 1979. The geology and mineral potential of the Las Petas - San Matias area. Map at 1:250,000.
9. O'Connor, E.A. et. al. 1979. The geology and mineral potential of the San Jose de Chiquitos area. Map at 1:250,000.

Phase 11 1980-1983

10. Annells, R.N., Hawkins, M.P. et. al. 1982. The geology and mineral potential of the Huachi and Ascension de Guarayos areas. 2 Maps at 1:250,000.
11. Annells, R.N., Burton, C.C.J., et. al. 1984. The mineral resources of the Rincon del Tigre igneous complex. Various maps.
12. Appleton, J.D. and Llanos, A., 1982. Geochemical prospecting for base metals in the San Jose de Chiquitos in lier. Various maps.
13. Appleton, J.D. and Llanos, A., 1982. Prospecting for tin in the Ascension de Guarayos and Concepcion area. Various maps.
14. Appleton, J.D., Burton, C.C.J. and Llanos, A., 1983. Pegmatities, Quartz veins and quartz-breccia reefs in the Precambrian shield of eastern Bolivia. Map at 1:500,000.
15. Berrange, J. P. and Litherland, M., 1982. Synopsis of the geology and mineral potential of the Proyceto Precambrico area, Southern and Northern Zones. (2 maps at 1:100,000).
16. Burton, C.G.J., et. al. 1986. An investigation of the mineral resources of Cerro Manomo. Various maps.

17. Hawkins, M.P., et. al. 1982. The geology and mineral potential of the Magdalena area. Map at 1:250,000.
18. Klinck, B.A., O'Connor, E.A., et. al., 1982. The geology and mineral potential of the Perseverancia and Monte Verde areas. 2 Maps at 1:250,000.
19. Litherland, M. et. al. 1982. The geology and mineral potential of the Huanchaca area. Map at 1:250,000.
20. Pitfield, P.E.J., Power, G., et. al. 1983. The geology and mineral potential of the Magdalena area. Map at 1:250,000
21. Pitfield, P.E.J., et. al. 1983. The geology and mineral potential of the Puerto Villazon area.

Phase 111 1983-1986

22. Bennett, M.J., et. al. 1985. The La Bella Pegmatite Field. Various maps.
23. Shaw, A.J., et. al. 1985. An investigation of the nickel resources of the Rincon de Tigre Igneous Complex. various maps.
24. Bennett, M.J., et. al. 1986. The San Ramon Gold Province. Various maps.
25. O'Connor, E.A., Shaw, A.J., et. al. 1986. The geology and mineral potential of parts of Southeast Bolivia. Various maps.
26. Bennett, M.J., Burton, C.G.J., Shaw, A.J., et. al. 1986. The geology and mineral potential of the Guayaramerin areas. Various maps.

C. BGS Publications

Annells, R.N. and 5 others 1986. The Rincon del Tigre Igneous Complex: a major layered ultramafic-mafic intrusion of Proterozoic age in the Precambrian shield of eastern Bolivia. Overseas Geology and Mineral Resources, No. 63, pp 64, coloured map scale 1:100 000. Price £10.50

Appleton, J.D. and Llanos, A. 1985. Geochemical Atlas of Eastern Bolivia, 12p with 22 1:1000,000 maps, Keyworth. Price US \$250.

Berrange, J.P. and Bushell, D., 1986. Topographic Map of Proyecto Precambrico Northern Zone. scale 1:500 000, in colour. Price £5.00.

Litherland, M. and 15 others, 1986. The geology and mineral resources of the Bolivia Precambrian shield. Overseas Memoir, British Geological Survey, No. 9, pp. 154, coloured map scale 1:1000 000. Price £25.00.

Litherland, M., 1984. Geological Map of the Proyecto Precambrico Area 1:1000 000, in colour. Price £5.00.

A. List of Publications

External publications

1. Annells, R.N., Fletcher, C.N.J. and Appleton, J.D. A major ultramafic-mafic layered intrusion of Proterozoic age : the Rincon del Tigre igneous complex, eastern Bolivia. In "Proceedings fourth Latin America geological congress, Port of Spain, Trinidad and Tobago". 1979 in press.
2. Annells, R.N., Fletcher, C.N.J., Styles, M.T., Appleton, J.D, Burton, G.C.J., Evans, R.B. and Harding, R.R. Mineral potential of the Rincon del Tigre Igneous Complex: a major Upper Proterozoic layered intrusion in the shield of Eastern Bolivia. In "Metallogeny of Basic and Ultrabasic Rocks" I.M.M. in press.
3. Berrange, J.P. 1982. The Eastern Bolivia Mineral Project "Proyecto Precambrico. Episodes, Vol. 1982. No 4 p. 3-8.
4. Bloomfield, K. 1979. Proyecto Precambrico - an integrated geological survey and mineral exploration programme in eastern Bolivia. Ann VI Conv. Nac. Geol. Bolivia, Oruro v. 6 (1), p 61-88.
5. Boulange, B. and Litherland, M., 1978. Surface de plannissements en la zone amazonienne de Bolivie (Region de San Ignacio de Velasco - Santa Cruz). Cah. ORSTOM Ser., Geol. Vol X. No. 1 pp 145-151. Paris.
6. Darbyshire, D.P.F. and Fletcher, C.J.N. 1979. A Mesozoic alkaline Province in eastern Bolivia. Geology, Vol. 7. p. 540-548.
7. Fletcher, C.J.N. and Litherland, M., 1981. The geology and tectonic setting of the Velasco Alkaline Province, eastern Bolivia. J. Geol. Soc., Vol. 138 pp. 541-548. London.
8. Fletcher, C.J.N., Appleton, J.D., Webb, B.C., Basham, I.R., 1981. Mineralisation in the Cerro Manomo Carbonatite Complex, Eastern Bolivia. Trans. Inst. Min. Met., Vol. 90 pp. B37-B50.
9. Fletcher, C.J.N., E. Aguilera A., Appleton, J.D., Bloomfield, K., Llanos, A. and Roberts, J.L. 1978. Tin in Eastern Bolivia? Trans. Intl. Tin Symp. La Paz.
10. Fletcher, C.J.N. and Beddoe-Stephens, B. 1986. The petrology, chemistry and crystallization history of the Velasco Alkaline Province, eastern Bolivia, in Alkaline Igneous Rocks. Special Publication, Geological Society of London.
11. Litherland, M, and Bloomfield, K. 1981. The Proterozoic history of eastern Bolivia. Precambrian Research, Vol. 15 pp. 157-179. Amsterdam.
12. Litherland, M. and Pitfield, P.E.J. 1983. The Mesozoic-Cenozoic history of eastern Bolivia and the recognition of four age's of duricrust. Proceedings of II International Seminar of Laterisation Processes, Sao Paulo, IGCP Project 129. Sao Paulo, pp. 281-294.
13. Litherland, M., Klinck, B.A., O'Connor, E.A., Pitfield, P.E.J. 1985. Andean-trending mobile belts in the Brazilian Shield. Nature, Vol. 314, No. 6009, pp. 345-348.
14. Litherland, M. and 10 others. The Proterozoic of Eastern Bolivia its relationship to the Andean Mobile Belt. Precambrian Research. In press.

15. O'Connor, E.A., Pitfield, P.E.J., Litherland, M., 1987. Landscape and Landsat over the Eastern Bolivian Shield. 8 pp. (Paper submitted to Zeitschrift fur Geomorphologic - special volume on laterite from 1st International Conference on Geomorphology. Manchester, September 1985).
16. O'Connor, E.A. and Walde, D.H.G. 1986. Recognition of an Eocambrian Orogenic Cycle in SW Brazil and SE Bolivia. Zbl. Geol. Palaont., Teil 1., p 1441-1456. Stuttgart.

ODA/BRITISH GEOLOGICAL SURVEY**FORM A3****PROJECT COMPLETION FORM****PROJECT NO: 6****TITLE:** MINERAL RESOURCES AND GEOLOGICAL ADVISORS**LOCATIONS:** Brazil**PROJECT SIZE:** 4**DATES:** 1970-74**COLLABORATING ORGANISATIONS**

Instituto do Desenvolvimento Economico-Social do Para, (IDESP) Belem
Instituto de Geosciences, Federal University of Bahia
University of Brasilia
Departamenio Nacional de Producão Mineral (Proyecto RADAM)
State of Piaui

PROJECT OBJECTIVES

To provide assistance in assessing limestone and other mineral resources in the states of Para. To act as consultant on the geology of the Roraima Territory in NW Brazil and to assist in the interpretation of side look radar imagery of the region (Proyecto RADAM)

To advise on setting-up a photogeology and remote sensing department at the Federal University of Bahia.

To install and monitor a telemetered array of seismic stations on the Brazilian Plateau to provide a more complete coverage along the Andean Chain.

To provide a three month course in photogeology and geological surveying for IDESP.

To assess and survey opal and diamond deposits in the state of Piaui, to identify new resources and extraction schemes.

PROJECT RESULTS

The project objectives were fully realized.

OUTPUT (Reports, Papers, & etc)

Cogger N and Rundle, L M. 1972. The Chemical analysis of limestones from Brazil Analytical Chemistry Unit, Report No 84. Institute of Geological Sciences.

Jobbins, E A. 1973. Assessment of diamond, opal and other mineral deposits in the State of Piaui, Brazil. Petrology Unit Report No.37. Institute of Geological Sciences.

WORKSHOPS AND PRESENTATIONS

Photogeology course, (IDESP) Belem, Brazil 1972 (10 geologists instructed)

Presentation at Brazilian Geological Conference, Belem 1972

PROJECT STAFF

Dr J P Berrangé

Dr B N Fletcher

N R Cameron

P G Linzell (Independent Consultant)

Dr I McReath

E A Jobbins

FUNDING ODA Technical Cooperation

ODA/BRITISH GEOLOGICAL SURVEY**FORM A3****PROJECT COMPLETION FORM****PROJECT NO: 7****TITLE:** "MAGELLAN PROJECT", SOUTHERN CHILE**LOCATIONS:** Chile**PROJECT SIZE:** 3**DATES:** 1969-70**COLLABORATING ORGANISATIONS**

Instituto de Investigaciones Geologicas, Santiago

PROJECT OBJECTIVES

Reconnaissance Mineral Exploration of southern Chile (Navarino and Western sectors)

Training of counterpart geologists in field techniques, geochemical sampling and laboratory analysis.

PROJECT RESULTS

The reconnaissance mineral exploration was completed for the Navarino and Western sectors (54°52'-55°24'S, 66°-25'-68°30'W), the maps and reports listed overleaf describe the findings.

A dozen geochemical anomalies with high values of either molybdenum, copper, nickel, lead or zinc were identified.

OUTPUT (Reports, Papers, & etc)

Cruzat, A, Fuerzalida, R, Page, B, Stambuk, V, Stewart, J W and Suarez, M. 1970. Estudio Geologico Economico de la Comceda de Navarino.

Stewart, J W, Cruzat, A, Page, B, Suarez, M, Stambuk, V. 1971. Estudio Geologico Economico de la Cordillera Patagonia entre los paralelos 51°00'-53°30'S, Provincia de Magallanes

WORKSHOPS AND PRESENTATIONS**PROJECT STAFF**

Dr B G N Page

Dr J W Stewart

FUNDING ODA Technical Cooperation

ODA/BRITISH GEOLOGICAL SURVEY**FORM A3****PROJECT COMPLETION FORM****PROJECT NO: 8**

TITLE: GEOLOGICAL ADVISORS	
LOCATIONS: Chile	PROJECT SIZE: 3 DATES: 1970-74
COLLABORATING ORGANISATIONS Instituto de Investigaciones Geologicas (IIG) Empresa Nacional de Minería	
PROJECT OBJECTIVES To provide geological advisors to Chilean parastatal bodies in the fields of geochemistry and hydrogeology. To assist with national plans for mineral exploration and development. Slope stability studies at the El Teniente Mine.	
PROJECT RESULTS Two resident advisors were provided, in Geochemistry (1971-74) and in Hydrogeology (1972) plus short-term advisory visits in the fields of Engineering Geology and Geophysics. The geochemical advisor helped to establish a Geochemistry Division at IIG comprising 13 professional staff and support workers equipment was donated by ODA and studies conducted involved exploration for copper, nickel and coal. The hydrogeological advisor assisted studies of water supply schemes for copper processing in arid N Chile including well siting and drilling.	
OUTPUT (Reports, Papers, & etc)	
WORKSHOPS AND PRESENTATIONS Course in geochemical prospecting, University of Chile 1972	

PROJECT STAFF

Dr B G N Page (Geochemist)
J W Lloyd (Hydrogeologist)
C B Campbell
P J Moore
B Denness

FUNDING ODA Technical Cooperation

ODA/BRITISH GEOLOGICAL SURVEY FORM A3**PROJECT COMPLETION FORM****PROJECT NO: 9****TITLE:** REGIONAL GEOLOGY, VALLE, SOUTHWEST COLOMBIA**LOCATIONS:** Colombia**PROJECT SIZE:** 2**DATES:** 1980-4**COLLABORATING ORGANISATIONS**

Instituto Nacional de Geología y Minas (INGEOMINAS) Cali

PROJECT OBJECTIVES

Regional geological mapping and mineral exploration of 16.500 km² of the Western and Central Cordilleras and the Cauca valley around Cali, SW Colombia, supported by age-determination and geophysical studies from BGS.

To help establish a new regional office of INGEOMINAS in Cali and the installation of a geochemical laboratory.

To train counterpart geologists in field mapping and mineral exploration techniques.

PROJECT RESULTS

The area identified was surveyed geologically supported by geochemical, isotope and geophysical studies. Geological maps and accounts of the area were published (detailed overleaf) and several fundamental advances in the geology and structure of the area were achieved.

Porphyry-copper mineralization was discovered in the Central Cordillera whilst Tertiary alluvial gold deposits comprise the main potential of the Western Cordillera.

A geochemical laboratory enabling routine analysis for a dozen elements was installed in INGEOMINAS, Cali to enable the work to be extended.

OUTPUT (Reports, Papers, & etc)

List of Map Reports (In Spanish) presented to INGEOMINAS for publication:-

McCourt, W J, Mosquera, D, Nivia, A and Nunez, A. Armenia, Sheet 243.

Armas de, M, Tulua, Sheet 261.

McCourt, W J. Genova, Sheet 262.

Aspden, J A and Nivia, A. Bahia de Buenaventura, Sheet 278.

Aspden, J A, Nivia, A and Millward, D. IDagua, Sheet 279.

McCourt, W J, Millward, D of Espinosa, A. Palmira, Sheet 280.

Verdugo, G and Aspden, J A. Jamundi, Sheet 299.

McCourt, W J and Verdugo, G. Cali, Sheet 300.

McCourt, W J. Generalized Geology, Departamento del Valle de Cauca (in English).

Project Reports:-

Vergara, H and Aucott, J W. Geochemical prospection in the La Marina area, Department of Valle del Cauca. Report No 1 (English and Spanish).

Vergara, H and Aucott, J W. Preliminary Soil Geochemistry and Electrochemistry of the El Pismo Area, Department of Valle del Cauca. Report No 2 (English and Spanish).

Aucott, J W and Vergara, H. Geochemical prospection in the Trujillo - Naranjal area. Department of Valle del Cauca. Report No 3 (English and Spanish).

Aucott, J W. Regional geochemistry and economic potential of base metal mineralization in the Department of Valle del Cauca. Report No 4 (English and Spanish).

Aucott, J W, Vergara, H and Millward, D. Detailed geochemical and geological studies at Vijes, Department of Valle del Cauca. Report No 5 (English and Spanish).

Aucott, J W. Detailed geochemistry of the Pance area, Department of Valle del Cauca. Report No 6 (English and Spanish).

Aspden, J A. The geology of the Western Cordillera and Pacific Coastal Plain in the Department of Valle del Cauca (Sheets 261, 278, 279, 280 and 299). Report No 7 (English).

McCourt, W J. The geology of the Central Cordillera in the Department of Valle del Cauca, Quindio and (NW) Tolima (Sheets 243, 261, 262, 280 and 300). Report No 8 (English).

Bermudez, A, Garzon, M, Evans, R B and Aucott, J W. Estudio gravimetrico del Valle del Rio Cauca, Department del Valle del Cauca. Report No 9 (Spanish).

Brook, M. New radiometric age data from SW Colombia. Report No 10 (English).

Aucott, J W. Project Summary. Report No 11 (English and Spanish).

Scientific Publications:-

Aucott, J W. 1983. The application of moving average analysis to seismic data and its interpretation related to the structure of Ecuador and Colombia. 10th Caribbean Geological Congress Cartagena.

McCourt, W J and Aspden, J A. 1983. A Plate Tectonic Model for the Phanerozoic Evolution of Central and Southern Colombia. 10th Caribbean Geological Congress Cartagena.

McCourt, W J, Aspden, J A and Brook, M. 1984. New geological and geochronological data from the Colombian Andes: continental growth by multiple accretion. Journal Geological Society London 141, 831-45.

McCourt, W J. 1984. A Palaeozoic paried metamorphic belt in the Central Cordillera of Colombia. BGS Report 16/1, 22-27.

Millward, D, Marriner, G F and Saunders, A D. 1984. Cretaceous tholeiitic volcanic rocks from the Western Cordillera of Colombia. Journal Geological Society London, 141, 847-60.

Marriner, G F and Millward, D. 1984. The petrology and geochemistry of Cretaceous to recent volcanism in Colombia: the magmatic history of an accretionary plate margin. Journal Geological Society London 141, 473-86.

McCourt, W J. 1984. Aspectos del metamorfismo y tectonismo regional en la Cordillera Central (Valle, Colombia). Proceedings 4th Congress of Colombian Geology, Cali.

McCourt, W J and Feininger, T. 1984. High-pressure metamorphic rocks in the Central Cordillera of Colombia. BGS Report 16/128-35.

Aspden, J A, McCourt, W J and Brook, M. 1987. Geometrical control of subduction-related magmatism: the Mesozoic and Cenozoic plutonic history of Western Colombia. Journal of the Geological Society of London Vol 144, 893-905.

WORKSHOPS AND PRESENTATIONS

Presentations at:

4th Congress of Colombian Geology, Cali, Colombia 1982

11th International Geochemical Exploration Symposium, Toronto 1985

10th Caribbean Geology Congress Cartagena, Colombia 1983

PROJECT STAFF

Dr J W Aucott (Project Manger)

Dr J Aspden

Dr McCourt

Dr D Millward

FUNDING ODA Technical Cooperation

ODA/BRITISH GEOLOGICAL SURVEY

FORM A3

PROJECT COMPLETION FORM

PROJECT NO: 10

TITLE: PACIFIC PRECIOUS METALS PROJECT	
LOCATIONS: Colombia	PROJECT SIZE: 3
	DATES: 1986-90
COLLABORATING ORGANISATIONS	
Instituto Nacional de Investigaciones Geológico y Mineras (INGEOMINAS)	
PROJECT OBJECTIVES	
Gold exploration and evaluation in the Pacific coast and Western flank of Colombia's Western Cordillera, SW Colombia	
On the job training of counterpart staff.	
PROJECT RESULTS	
A new model to explain the gold mineralization in the Pacific coast area was developed, relating the gold to Tertiary subvolcanic intrusive rocks.	
The richest gold deposits are found where mudflows have preserved old river deposits in ancient valleys.	
This fresh understanding of the occurrence of the gold deposits will guide future exploration efforts.	
Two counterpart geologists have completed MSc courses at British Universities funded by the British Council, others are proposed.	
OUTPUT (Reports, Papers, & etc)	
1:60 000 Geological Map & Report.	
Entwhistle, D. 1987. Physical properties of Tertiary sediments from the Pacific Coast area of Cauca, Colombia. BGS Engineering Geology Unit Report No 175.	
Evans, R B and Cuellar, J V. 1987. Geophysical prospecting for gold placers in the Pacific Coast area of Cauca, Colombia. BGS Technical Report RG/87/15.	
Annells, R N, Forero, O H F and Rodriguez, R C A. 1988. Geology and gold potential of the Timbiqui and Napi river basins, Cauca Department, Colombia. BGS Technical Report WC/88/45.	
Beddoe-Stephens, B. 1988. Summary of gold analytical results obtained during a visit to Bogota. BGS Technical Report WG/88/1R.	

Appleton, J D. 1989. Preliminary interpretation of geochemical data for the -125 μm fraction of the Phase I (MDP-Colombia) "fino" samples. BGS Technical Report WC/89/34.

Appleton, J D and Greally, K. 1990. Cali Geological Training Project MPP-II. Report of the Geochemical Survey. BGS Technical Report WC/90/43R.

WORKSHOPS AND PRESENTATIONS

Lectures and Course provided by BGS staff in:

Remote Sensing INGEOMINAS Cali 1989

Mineral Processing Technology INGEOMINAS Cali and Bogota 1988

Geochemistry in Gold Exploration INGEOMINAS Cali 1989.

PROJECT STAFF

Dr R N Annells (Project Manager Phase 1, 1986-88)

Dr W J McCourt (Project Manager Phase 2, 1988-90)

Dr I R Basham

Dr B Beddoe-Stephens

D A Briggs

R B Evans

R C Jones

J L Roberts

Dr B J Amos

Dr J D Appleton

D Entwistle

FUNDING ODA Technical Cooperation

ODA/BRITISH GEOLOGICAL SURVEY**FORM A3****PROJECT COMPLETION FORM****PROJECT NO: 11**

TITLE: TALAMANCA CORDILLERA REGIONAL GEOLOGY	
LOCATIONS: Costa Rica	PROJECT SIZE: 4 DATES: 1975-7
COLLABORATING ORGANISATIONS Dirección de Geología, Minas y Petróleo (DGMP), Costa Rica British Museum (Natural History)	
PROJECT OBJECTIVES Photogeological study and field checking to produce geological maps of 3,000 km ² of the Talamanca Cordillera which was thought to contain major porphyry copper mineralization. Training of Costa Rican counterpart geologists in photogeology and field mapping. One counterpart geologist was sent to the UK for post-graduate training.	
PROJECT RESULTS One geological map covering 500 km ² and five photo-geological maps covering 2,500 km ² of the Talamanca Cordillera were produced. These provide the basis for future more detailed mapping and exploration for gold and porphyry copper deposits by Costa Rican geologists. The stratigraphy of a key area in the Talamanca Cordillera was sorted out by field mapping and palaeontological studies. One Costa Rican counterpart geologist (A Monge) gained a PhD in Mineral Economics from University of Leicester. He subsequently became Director of Costa Rica's state mining enterprise MINASA.	
OUTPUT (Reports, Papers, & etc) Berrangé, J P. 1977. Reconnaissance geology of the Tapantí Quadrangle, Talamanca Cordillera, Costa Rica. Institute of Geological Sciences Report No.37, 72p & 6 Maps. Berrangé, J P. 1977. Geological Map Photogeological Maps Tapantí Sheet 1:100 000 Pejibaye Sheet 1:50 000 Vueltas Sheet Cuerici Sheet Savegre Sheet San Isidro Sheet	

WORKSHOPS AND PRESENTATIONS
PROJECT STAFF Dr J P Berrangé Dr J E Whittaker (British Museum)
FUNDING ODA Technical Cooperation

ODA/BRITISH GEOLOGICAL SURVEY**FORM A3****PROJECT COMPLETION FORM****PROJECT NO: 12**

TITLE: TILARAN-AGUACATE GOLD PROJECT	
LOCATIONS: Costa Rica	PROJECT SIZE: 4 DATES: 1981-83
COLLABORATING ORGANISATIONS Corporacion Costarricense de Desarrollo (CODESA)	
PROJECT OBJECTIVES Geological mapping and gold exploration in the Tilaran-Aguacate mountains involving photogeology, field studies. Geochemistry and geophysical inputs. Provide advice on training in gold exploration and related laboratory techniques	
PROJECT RESULTS A geological map, report and geochemical analyses were published covering the Tilaran-Aguacate area (3500km ²). This will help guide future exploration for gold in the area, recommendations are made for geochemical sampling procedures and exploration targets are identified. Two short advisory visits were undertaken to CODESA laboratories in San Jose to advise on instrument calibration, laboratory environment, procedures, methodology, techniques, etc. The report (listed) provided an input to USGS "Mineral Resource Assessment of the Republic of Costa Rica".	
OUTPUT (Reports, Papers, & etc) Amos, B J and Rogers, P J. 1983. The Geology and exploration geochemistry of the Cordillera Tilaran-Montes del Aguacate Gold Field, Costa Rica. BGS Technical Report No 1983/3.	

WORKSHOPS AND PRESENTATIONS
PROJECT STAFF Dr B J Amos Dr P Rodgers J Roberts
FUNDING ODA Technical Cooperation

PROJECT COMPLETION FORM

PROJECT NO: 13

TITLE: VALLE CENTRAL HYDROGEOLOGY**LOCATIONS:** Costa Rica**PROJECT SIZE:** 4**DATES:** 1975 -1984 (Intermittent)**COLLABORATING ORGANISATIONS**

Servicio Nacional de Aguas Subterráneas, Riego, y Avenamiento (SENARA)
Instituto Costarricense de Acueductos y Alcantarillados (ICAyA)

PROJECT OBJECTIVES

Intermittent short-term advisory support to SENARA and ICAyA on groundwater abstraction in the Valle Central.

Construction of a preliminary aquifer mathematical model to simulate and evaluate future abstraction plans.

Preparation of a hydrogeological map of the Valle Central.

PROJECT RESULTS

Considerable advice and technical know-how has been provided to SENARA and TCAyA, on production borehole siting, design and protection, resource evaluation and modelling.

A hydrogeological map of the Valle Central has been published.

The work resulted in a World Bank Commonwealth Development Corporation-funded project (No.13 this volume) to investigate groundwater resource development and protection in greater detail.

OUTPUT (Reports, Papers, & etc)

Losilla, M and Rodriguez, H 1978 Consideraciones sobre recarga y descarga del acuífero de Colima en el area del Campo de Pozos de Santo Domingo. SENAS, informe tecnico 102:

Losilla, M, Foster, S, Rodriguez, H and Kitching, R. 1982. Estudio Hidrogeologico para el desarrollo de los acuíferos Colima. Aplicacion del modelo matematico IGS-SENARA. SENAS, informe tecnico 153.

BGS-SENARA, 1985. Hydrogeological map of the Valle Central of Costa Rica.

Foster, S, Ellis, A Losilla, M and Rodriguez, H, 1985. Role of volcanic tuffs in ground-water regime of Valle Central, Costa Rica. Ground Water, 23, No.6.

WORKSHOPS AND PRESENTATIONS**PROJECT STAFF**

Dr S S D Foster
J M Parker
Dr R Kitching
R A Monkhouse
A Williams

FUNDING ODA Technical Cooperation

PROJECT COMPLETION FORM

PROJECT NO: 14

TITLE: VALLE CENTRAL GROUNDWATER RESOURCES	
LOCATIONS: Costa Rica	PROJECT SIZE: 4 DATES: 1984-87
COLLABORATING ORGANSATIONS Servicio Nacional de Aguas Subterráneas Riego y Avenamiento (SENARA) Instituto Costarricense de Acueductos y Alcantarillados (ICAyA)	
PROJECT OBJECTIVES To carry out hydrogeological studies to enable ICAyA and SENARA to exploit more rationally the groundwater resources of the Valle Central (the major populated part of Costa Rica). To extend knowledge of the recharge and discharge of deep and superficial aquifers in the Valle Central, especially the key Colima Aquifer System. To assess the potential for further development of groundwater supplies on the northern side of the Valle Central.	
PROJECT RESULTS It is concluded that the Colima aquifer could yield a further 1000-1500 litres/sec with the construction of new wellfields. Whilst groundwater quality is excellent some aquifers are at risk of serious contamination, preventive measures are identified. Recommendations are made for future groundwater development, and management, further investigation requirements are identified.	

OUTPUT (Reports, Papers, & etc)

Rodriguez, H and Vasquez, C. 1984. Estudio Hidrogeologico para desarrollo de los acuíferos Colima. Aplicacion de modelo matematico IGS-SENARA. Senas Informe Technico, 153.

Perkins, M. 1985. Borehole flow logging in the Valle Central: Costa Rica visit, July 1985: BGS Report WD/OS/85/33.

BGS-SENARA. 1985. Further groundwater evaluation and development in the Valle Central, Costa Rica. Year 1 Technical Report. BGS Report WD/OS/85/32.

BGS-SENARA. 1987. Further groundwater evaluation and development in the Valle Central, Costa Rica. Year 2 Technical Report. BGS Report WD/OS/87/2.

Darling, G, Parker, J M, Rodriguez, H and Lardner, A. 1989. Investigation of a volcanic aquifer system in Costa Rica using environmental isotopes. In Proceedings of a Regional Seminar for Latin America on the use of isotope techniques in hydrogeology, Salazar, Mexico 1987. International Atomic Energy Agency.

British Geological Survey 1988. The continuation of hydrogeology investigations in the north and east of the Valle Central. Costa Rica: Final Report 1984-88. British Geological Survey Technical Report WD/88/13R.

Foster, S S D. 1990. Fundamental concepts in aquifer vulnerability, pollution risk and protection strategy. In Vulnerability of soil and groundwater to pollutants. 'TNO Committee on Hydrogeological Research, Hague. P69-86.

WORKSHOPS AND PRESENTATIONS

Presentations at:

Regional Seminar for Latin America on the use of isotope techniques in hydrology, Salazar, Mexico 1987

Circum - Pacific Council on Energy and Mineral Resources of Central America and the Caribbean, San, Jose, Costa Rica 1989.

Volcanic Hydrogeology Meeting, Madeira, 1989.

PROJECT STAFF

Dr S S D Foster
J M Parker
Dr R Kitching
G Darling
A Williams
J A M Cook
M Perkins

FUNDING World Bank and Commonwealth Development Corporation

ODA/BRITISH GEOLOGICAL SURVEY**FORM A3****PROJECT COMPLETION FORM****PROJECT NO: 15****TITLE:** INDUSTRIAL MINERALS SURVEY (PACOMI)**LOCATIONS:** Costa Rica**PROJECT SIZE:** 3**DATES:** 1987-91**COLLABORATING ORGANISATIONS**

Direccion de Geologia, Minas y Hidrocarburos (DGMH) 1987-89
Recope S A 1989-91
Ministerio de Recursos Natarales Energia y Minas (MIRENEM)

PROJECT OBJECTIVES

To complete a systematic inventory of Industrial Mineral occurrences in Costa Rica (Phase 1).
To undertake more detailed follow-up studies of selected commodities (Phase II).
To identify opportunities for import substitution and export of industrial minerals, to study regional markets.
To train counterpart staff to continue the work.

PROJECT RESULTS

A comprehensive 181-page inventory of industrial minerals in Costa Rica has been published, production and import/export statistics are included, opportunities for import substitution and export are identified.

Detailed follow-up studies identified 3 million tonnes of diatomite reserves suitable for filtration, thin beds of bentonite-rich clay and the very high purity Barra Honda Limestone resource which has export potential.

A post-graduate course on industrial minerals was developed at the University of Costa Rica; two counterpart staff have been given training in the UK - funded by the British Council.

High-technology applications related testing of several commodities was performed at BGS Keyworth. Some 20 publications listed overleaf describe the detailed work of the project.

A short consulting visit was made to Nicaragua to investigate the industrial mineral capacity.

OUTPUT (Reports, Papers, & etc)

Berrange, J P. 1988. Proyecto Anglo-Costarricense de minerales industrializables (PACOMI). in 1er Seminario la actividad minera en Costa Rica, San José. 18-31.

Inglethorpe, S D J and Bloodworth, A J. 1989. Preliminary assessment of diatomites from Costa Rica as raw materials for filter aids. BGS Mineralogy and Petrology Report WG/89/4R. (Restricted).

Mathers, S J, 1989. Costa Rican diatomite: a review of existing knowledge and future potential. Revista Geológica de América Central, 10, 3-17.

Bloodworth, A J. 1989. Report on a visit to Costa Rica, March 1989. BGS Mineralogy and Petrology Report WG/89/15R (Restricted).

Inglethorpe, S D J and Bloodworth, A J. 1989. Mineralogical and technical appraisal of common clays and limestones from Costa Rica. BGS Mineralogy & Petrology Report WG/89/16R (Restricted).

Mitchell, C J and Bloodworth, A J. 1989. Evaluation of Pumice from Costa Rica as lightweight aggregate. BGS Technical Report WG/89/21R.

Mathers, S J. Unpublished. Report on the conference 'Mexican industrial minerals in a world context, Monterrey, Mexico, 2-5 April 1989.

Mathers, S J. Unpublished, Report on a visit by PACOMI staff to Guatemala 5-9 June 1989. (Commercial in Confidence).

Inglethorpe, S D J. 1990. A visit to San Jose, Costa Rica BGS Technical Report WG/90/22R.

Inglethorpe, S D J. 1990. Mineralogical eumpcriton and filtration properties of a sample of diatomite from Loma Camastro. Costa Rica. BGS Technical Report WG/90/13R.

Berrangé, J P and Mathers, S J. 1990. Los Minerales Industriales Nometalicos de Costa Rica. Revista Geológica de América Central No 11, 85-90.

Berrangé, J P, Mathers, S J, Morales, N and Alvarado, F. 1990. The non-metallic Industrial Minerals and Rocks of Costa Rica. BGS Technical Report WC/90/22. 181 p.

Mathers, S J, Chavez, L, Alvarado, F and Inglethorpe, S D J. 1990. Detailed Investigations of selected Costa Rica Diatomites. BGS Technical Report WC/90/35.

Mathers, S J, Harrison, D J and Alvarado, F. 1990. An assessment of the potential of the Barra Honda Limestone and Guanacaste Province, Costa Rica. BGS Technical Report WC/90/37.

Mathers, S J, Madrigal, J E and Alvarado, F. 1990. Results of an initial exploration programme for bentonitic clays in Costa Rica. BGS Technical Report WC/90/36.

Mathers, S J, Inglethorpe, S D J and Bloodworth, A J. In press. A provisional study of Costa Rican diatomites as raw materials for filter-aids. In Proceedings of the Circum-Pacific Council symposium 'Energy and Mineral Resources of the Caribbean-Central America Region'. San José, Costa Rica.

OUTPUT (Reports, Papers, & etc)

Mathers, S J and Morales, N. In press. The occurrence, production and trade of non-metallic industrial minerals in Costa Rica. In Proceedings of the Circum-Pacific Council symposium 'Energy and Mineral Resources of the Caribbean-Central America Region', San José, Costa Rica.

Berrangé, J P. 1991. Non-metallic Industrial Minerals of Costa Rica - A Status Report. Industrial Minerals.

Mathers, S J. In press. The non-metallic industrial minerals of Costa Rica. Revista Geologica de America Central.

Mathers, S J and Morales, N. In press. The non-metallic industrial minerals of Costa Rica. Revista Geologica de America Central.

Mathers, S J, Alvarado, F and Inglethorpe, S D J. In press. Limestone, an important industrial mineral for Costa Rica. Proceedings of 2nd Mining Seminar San Jose, Costa Rica 1989.

WORKSHOPS AND PRESENTATIONS

Post-graduate University course in Industrial Minerals presented at the University of Costa Rica, 1990.

Two 'on the job' working seminars provided in limestone and bentonite assessment.

Papers read at:

- 1st National Symposium on Mining, San José 1988
- Circum - Pacific Conference, San José 1990
- 2nd National Symposium on Mining San José 1990

PROJECT STAFF

Dr J P Berrangé (Project Manager 1987-89) Phase I
S J Mathers (Project Manager 1989-91) Phase II
D J Harrison
C J Mitchell
A J Bloodworth
S D J Inglethorpe

FUNDING ODA Technical Cooperation

TITLE: REGIONAL GEOLOGY - LOJA & LLANGANATES

LOCATIONS: Ecuador

PROJECT SIZE: 3

DATES: 1969-70

COLLABORATING ORGANISATIONS

United Nations Development Programme (UNDP)
Servicio Nacional de Geología y Minería

PROJECT OBJECTIVES

UK-based photogeological interpretation, followed by field checking, to produce 1:1 000 000 geological maps of 17.500 km² of terrain in the Loja and Llanganates areas of Ecuador.

Training Counterpart staff in Photogeology

Publication of 1:100 000 Geological Maps of the areas identified

PROJECT RESULTS

The six 1:100 000 geological maps planned were produced and published

Samples were collected in the Loja area for a UNDP Mineral Survey Project - these were analyzed in UNDP Laboratories in Ecuador.

A counterpart Ecuadorian geologist was given 5 months training in Photogeology in the UK

OUTPUT (Reports, Papers, & etc)

Maps

1 ¼ ° Sheet Llanganates Area 1:100 000

5 ¼ ° Sheets Loja Area 1:100 000

Snelling, N J. 1970. K:Ar age determinations on samples from Ecuador. IGS Isotope Geology Unit Report, No 70/10, 4p.

Snelling, N J and others, 1970. K:Ar age determinations on samples from Ecuador. IGS Isotope Geology Unit Report, No 70/18, 5p.

Kennerley, J B and Bromley, R J. 1971. Geology and geomorphology of the Llanganates Mountains, Ecuador. Contribuciones, Instituto Ecuatoriano de Ciencias Naturales, No 73.

Kennerley, J B. 1973. Geology of Loja Province, southern Ecuador. IGS Photogeological Unit, No 23, 34p.

WORKSHOPS AND PRESENTATIONS**PROJECT STAFF**

J B Kennerley

FUNDING ODA Technical Cooperation

ODABRITISH GEOLOGICAL SURVEY**FORM A3****PROJECT COMPLETION FORM****PROJECT NO: 17****TITLE:** REGIONAL GEOLOGY AND MINERAL EXPLORATION**LOCATIONS:** Ecuador**PROJECT SIZE:** 1**DATES:** 1972-80**COLLABORATING ORGANISATIONS**

Direccion General de Geologia y Minas (DGGM)
Instituto Geografico Militar (IGM) (for pre printing of all maps)
British Museum

PROJECT OBJECTIVES

Regional Geological Mapping of extensive areas of the Andean Chain and Pacific Coastal Plain of Ecuador; involving photogeological interpretation and fieldwork.

Production of 1:100 000 geological maps and a revised 1:1M geological map of Ecuador, with explanation.

Associated exploration for metallic and industrial minerals

Engineering geology studies especially around the capital, Quito.

Training counterpart staff in laboratory techniques, drafting and production of computer databases. Institution Building.

PROJECT RESULTS

61 ¼° Sheets covering in area of 125.000 km² (half the size of Britain) were surveyed geologically, the geological maps were published at 1:100 000 scale.

The survey remapped about 40% of Ecuador, and a new National Geological map at 1:1 million scale and geological explanation were produced using the findings.

Several zones of copper mineralization were discovered in the Western Cordillera, and important occurrences of phosphate in the Napo area (sub-Andean belt).

A Geochemical laboratory including atomic absorption spectrometry equipment and associated computing facilities donated and installed.

Engineering geology and geotechnical studies were carried out around Quito.

Cartographic training and supervision in geological map making, were provided.

15 training awards were provided for Ecuadorian staff to receive MSc courses and training in the UK.

OUTPUT (Reports, Papers, & etc)

Maps

61 1:100 000 scale geological maps of ¼° sheets covering 40% of Ecuador (not listed in detail)

New geological map of Ecuador 1:1000 000 scale with explanation. Baldock, J W and Longo R. 1982 Geology of Ecuador DGGM Quito.

Other publications

Bristow, C R. 1973. Guide to the geology of the Cuenca Basin. Southern Ecuador. Ecuador Geological and Geophysical Society.

Anonymous. 1974. Mineralogy of clays from Ecuador. Applied Mineralogy Unit, No 137, GD 87.43/1, 5pp.

Bristow, C R. 1975. On the age of the Zapotal Sands of southwest Ecuador. Newsletters in Stratigraphy, Vol 4, pp 119-134.

Bristow, C R. 1975. The age of the Cayo Formation, Ecuador. Newsletters in Stratigraphy, Vol 4, pp 169-173.

Carruthers, R M and Greenwood, P G. 1975. Report on electromagnetic surveys in Ecuador, September/October 1975. Applied Geophysics Series, No 16.

Stacey, F R and Waine, E. 1975. The assessment of pozzolanic properties of a sample from Ecuador. Analytical Chemistry Unit, No 100, 5pp.

Beckinsale, R D. 1976. K:Ar age determinations on samples from Ecuador. Isotope Geology Unit, No 76.11, 4pp.

Bristow, C R. 1976. The Charapoto Formation, Ecuador, Newsletters in Stratigraphy, Vol 5 (3), pp 99-103.

Bristow, C R. 1976. On the age of the Nabon Formation, Ecuador. Newsletter Stratigraphy, Vol 5 (3), pp 104-7.

Bristow, C R. 1976. The Daule Group, Ecuador. Newsletters in Stratigraphy, Vol 5 (3), pp 190-200.

Bristow, C R. 1977. Guia a la geologia de la Cuenca de Cuenca. (Quito: Ecuadorian Geology and Geophysics Society).

Wilkinson, A F. 1977. Guia para una geologia y prospeccion de los fosfatos. Rev DGGM, No 8.
Bristow, C R and Hoffstetter, R. 1977. Lexique Stratigraphique International (Ecuador) 2nd Edition.

Greenwood, P G and Smith, I F. 1978. Applied geophysical surveys in Ecuador in technical cooperation with Direccio General de Geologia y Minas. Applied Geophysics Series, No 41, 32p.

Baker, M C and Francis, P. 1978. Upper Cenozoic volcanism in the central Andes. Isotope Geology Unit, No 78.6, 5pp.

Atkin, D. 1979. XRD examination of phosphate samples from Ecuador. File 87.25/1, No 8474.

Bristow, C R. 1979. Discussion of Henderson, W G. 1979 Cretaceous to Eocene volcanic arc activity in the Andes of northern Ecuador. Journal Geological Society London, Vol 136, pp 367-378]. Journal Geological Society London, Vol 136, pp 367-377.

Henderson, W G. 1979. Cretaceous to Eocene Volcanic activity in the Andes of northern Ecuador [with discussion]. Journal of the Geological Society of London, Vol 136, pp 367-378:

Whittaker, J E and Hodgkinson, R L. 1979. Micropalaeontological report on the Napo Formation, Eastern Ecuador. British Museum (Natural History), Rep OGS, No 1979/1, 4p.

Wilkinson, A F. 1979. Phosphate in Ecuador - a preliminary investigation. Institute of Geological Sciences, (Overseas Division), Keyworth, Nottingham, England. 109pp. [Unpublished]

Bristow, C R and Feininger, T. 1980. Cretaceous and Paleogene geologic history of coastal Ecuador. Geologische Rundschau, Vol 69, pp 849-874.

Kennerley, J B. 1980. Outline of the geology of Ecuador. Overseas Geology and Mineral Resources, No 55 IGS:

Henderson, W G and Evans, C D R. 1980. [Discussion of] Ecuadorian subduction system. Bulletin American Association of Petroleum Geologists, Vol 64, pp 280-283.

Evans, C D R and Whittaker, J E. 1981. The geology of the western part of the Borbon Basin. North-west Ecuador. In Leggett, J K (editor), Trench and fore-arc sedimentation and tectonics in modern and ancient subduction zones. Special Publication, Geological Society of London, No 10, pp 191-198.

Bristow, C R. 1981. An annotated bibliography of Ecuadorian geology. IGS Overseas Geology and Mineral Resources. Report No 58.

Bristow, C R and Parodiz, J J. 1982. The stratigraphical paleontology of the Tertiary non-marine sediments of Ecuador. Bulletin Carnegie Museum, No 19, pp 1-53.

Wilkinson, A F. 1982. Exploration for phosphate in Ecuador. Transactions of the Institution of Mining and Metallurgy, Vol 91, pp B130-145.

Baldock, J W. 1985. The Northern Andes: a review of the Ecuadorian Pacific Margin. In: Ocean Basins and Margins: Pacific Volume p 181-217.

WORKSHOPS AND PRESENTATIONS

Photogeology Course, Escuela Politecnica Nacional Quito 1975

Geochemistry in Mineral Exploration, Politecnica Nacional Quito 1978

PROJECT STAFF

J B Kennerley (Project Manager 1972-6)
Dr J W Baldock (Project Manager 1977-80)
Dr C R Bristow
R F Randel
Dr J W Aucott
Dr A F Wilkinson

Dr C Mortimer OBE
Dr J E Whittaker (British Museum)
R M Carruthers
Dr B Denness
J L Roberts
R B Evans

P G Greenwood
W G Henderson
Dr C D R Evans
R I Johnson
S Tucker

FUNDING ODA Technical Cooperation

ODA/BRITISH GEOLOGICAL SURVEY**FORM A3****PROJECT COMPLETION FORM****PROJECT NO: 18****TITLE:** GEOLOGY OF THE CORDILLERA REAL**LOCATIONS:** Ecuador**PROJECT SIZE:** 2**DATES:** 1986 - On Going**COLLABORATING ORGANISATIONS**

Instituto Nacional Ecuatoriano de Minería (INEMIN)

PROJECT OBJECTIVES

Regional geology and mineral studies supported by geochronology and geochemical programme to elucidate the mineral potential of the poorly understood Cordillera Real of eastern Ecuador.

In particular to identify the source of gold deposits found for many centuries in this region, and to identify zones of base metal mineralization by undertaking traverses across the Cordillera Real.

Training of counterpart staff.

PROJECT RESULTS

To-date the geology of the Cordillera Real has been defined by a series of geotraverses.

Areas of potential mineralization of several distinct types have been identified.

The on-going project (Phase 3) now has three main components:

- 1) Studying polymetallic veins and breccias with mineral potential.
- 2) Reconnaissance of the geological basement in SW Ecuador to reveal mineral potential.
- 3) National Map Programme, compiling geologic, tectonic and metallogenic maps of Ecuador.

OUTPUT (Reports, Papers, & etc)

Aspden, J A, Duque, P, Salazar, E, Bermudez, R and Viteri, F. 1987. Un nuevo cinturón ofiolítico en la Cordillera Real, Ecuador, y su posible significado regional. Politecnica Quito, Vol 12, No 2, pp 81-93.

Aspden, J A and Litherland, M. 1987. Ophiolitic rocks from the Cordillera Real of Ecuador: their regional significance within the context of the Northern Andes. Terra Cognita, Vol 7, No 2-3, p 419.

BGS. 1987. Cordillera Real Geological Research Project. First Annual Report (March 1986 - March 1987).

Beddoe-Stephens, B. 1987. A pilot examination of alluvial and in situ gold and platinum from Ecuador: BGS Mineralogy and Petrology Report No 87/3.

Rundle, C C. 1987. Reconnaissance K-Ar ages for the Cordillera Real Project, Ecuador BGS Isotope Geology Unit Report No 87/5.

Rundle, C C. 1987. Rb-Sr analysis of rocks collected in May/June 1987 for the ODA-funded Cordillera Real Project, Ecuador NERC Isotope Geology Centre Report No 87/1.

Harrison, S M. 1990. Radiometric Ages (Rb-Sr, K-Ar and Sm-Nd) for rocks from the Cordillera Real Ecuador. BGS Technical Report WC/90/12.

Clarke, M C G. 1989. Contribution to the understanding of the mineral potential of the southern Ecuadorean Andes. BGS Technical Report WC/89/12.

Litherland, M. 1988. La geología mas apasionante. Minera Ecuatoriana, Vol 1, pp 16-20.

BGS. 1988. Cordillera Real Geological Research Project. Second Annual Report (April 1987 - March 1988).

WORKSHOPS AND PRESENTATIONS

Training courses provided at INEMIN

- a) Economic Geology (with emphasis on gold)
- b) Petrography

PROJECT STAFF

Dr M Litherland (Project Manager)
Dr J Aspden
Dr R Jemielita
Dr B Beddoe-Stephens
C C Rundel
Dr T J Shepherd

Dr N J Fortey
Dr M C G Clarke
S M Harrison

FUNDING ODA Technical Cooperation

ODABRITISH GEOLOGICAL SURVEY**FORM A3****PROJECT COMPLETION FORM****PROJECT NO: 19****TITLE:** REGIONAL GEOLOGY, SOUTHERN GUYANA**LOCATIONS:** Guyana**PROJECT SIZE:** 2**DATES:** 1966-71**COLLABORATING ORGANISATIONS**

Geological Survey of Guyana

PROJECT OBJECTIVES

Reconnaissance photogeological and field mapping of Guyana south of 4°N covering about 64 000 km² of territory to produce geological maps and an account of the geology of the area; and to identify its mineral potential.

PROJECT RESULTS

The first systematic geological maps of 64,000 km² of southern Guyana (S of 4°N) were produced as follows:

Nine degree square geological maps at 1:200,000

One tectonic/geological map of southern Guyana at 1:500,000

One geomorphological map of southern Guyana at 1:500,000

These primary maps were subsequently utilised for the construction of a revised 1:1 M geological map of Guyana.

A memoir describing the geology of the region was produced Nine substantive scientific papers on the Geology, geomorphology and archaeology of the region were published.

Recommendations on the disused Marudi Gold Mine led to renewed interest in it by North American mining companies. It is at present being drilled by Sutton Resources Ltd with promising assay results.

The North Savannas Rift Valley was first identified and subsequently investigated by North American petroleum companies as a possible source of oil and gas.

Recommendations led to the agate nodules in the North Savannas Rift Valley being utilised for a lapidary workshop subsequently set up by ODA/BGS in Georgetown.

OUTPUT (Reports, Papers, & etc)

Berrangé, J P. 1967. Geologist hopes to make Sir Walter Raleigh's dream come true. Overseas Development, No 2, pl.

Berrangé, J P. 1968. Operation el Dorado: A UK-Guyana photogeological project. Overseas Development, No 13, p 10.

McConnell, R B, Masson Smith, D and Berrangé, J P. 1969. Geological and geophysical evidence for a rift valley in the Guiana Shield. *Geologie. Mijnbouw*, Vol 48, (2) p 189-200.

Berrangé J P. 1970. The riebeckite granite of Makarapan Mountain - a re-interpretation. Proceedings 8th Guiana Geological Conference, Georgetown, 1969, p II 1-13.

Berrangé J P. 1970. Operation el Dorado - A UK-Guyana photogeological mapping project. Proceedings 8th Guyana Geological Conference, Georgetown, 1969, p VI 1-8.

Snelling, N J and Berrangé, J P. 1970. The geochronology of Guyana II - Results obtained during the period 1966-1969. Proceedings 8th Guiana Geological Conference, Georgetown, 1969, p IV 1-15.

Hutchison, D. 1970. Chemical analysis of rocks from southern Guyana. IGS Analytical Chemistry Unit, No 58, 3pp.

Snelling, N J. 1970. K:Ar age determinations from southern Guyana. IGS Isotope Geology Unit, Report No 70.11, 5pp.

Spooner, C M, Berrangé, J P and Fairbairn, H W. 1971: Rb-Sr whole-rock age of the Kanuku Complex, Guyana. *Bulletin Geological Society America*, Vol 82, p 207-210.

Berrangé, J P and Johnson, R L. 1972. A guide to the upper Essequibo River, Guyana. *Geographical Journal*, Vol 138, Part 1, p 41-52, map.

Berrangé J P. 1972. The Tectonic/Geological Map of southern Guyana. Memoria IX Conferencia Geológica Inter-Guayanas. Boletín de Geología, Publicación Especial No 6, Caracas-Venezuela, p 159-178.

Berrangé J P. 1973: A synopsis of the geology of southern Guyana. IGS, Overseas Division, Report No 26, 16 p.

Berrangé J P. 1973. Degree square geological map (DOS 1182): Kanuku, 1:200,000, Directorate of Overseas Surveys, London.

Berrangé J P. 1974. Degree square geological maps of southern Guyana (DOS 1182): South Savannas, Oronoque Head with Aramatau and Kutari, 1:200,000, Directorate of Overseas Surveys, London.

Berrangé, J P and Johnson, R L. 1974. Degree square geological maps of Southern Guyana. (DOS 1182): Rewa, New River Mouth, Kuyuwini, New River Oronoque, Kassikaityu, Essequibo Head, 1:200,000, Directorate of Overseas Surveys, London

Berrangé, J P and Dearnley, R. 1975. The Apoteri Volcanic Formation - Tholeiitic flows in the North Savannas Graben of Guyana and Brazil. *Geologische Rundschau*, Band 64, Heft 3, p 883-899.

Berrangé, J P. 1975. The geomorphology of southern Guyana with special reference to the development of planation surfaces. Anais Décima Conferência Geológica Interguianas, Belém, p 804-824, map at 1:500,000.

Berrangé, J P. 1977. The geology of Southern Guyana, South America. Institute Geological Sciences, Overseas Memoir No 4, 112 p. Tectonic-Geological and Geomorphological Maps, 1:500,000.

Dubelaar, C N and Berrangé, J P. 1979. Some recent petroglyph finds in southern Guyana. Journal Archaeology and Anthropology, Vol 2, No 1, p 61-77.

WORKSHOPS AND PRESENTATIONS

Results presented at:

Eighth Guiana Geological Conference, Georgetown, 1969.

Ninth Guiana Geological Conference, Puerto Ordaz, 1972.

Tenth Guiana Geological Conference, Belem, 1975.

PROJECT STAFF

Dr J P Berrangé

Dr R L Johnson

FUNDING ODA Technical Cooperation

ODA/BRITISH GEOLOGICAL SURVEY**FORM A3****PROJECT COMPLETION FORM****PROJECT NO: 20**

TITLE: GEOLOGICAL ADVISORS	
LOCATIONS: Guyana	PROJECT SIZE: 5 DATES: 1973
COLLABORATING ORGANISATIONS Geological Survey of Guyana Land Resources Division, ODA	
PROJECT OBJECTIVES Establishing a lapidary to enable local craftsmen to cut and fashion decorative stone.	
PROJECT RESULTS The lapidary which was attached to the Geological Survey of Guyana was set-up and equipped by ODA. It operated very successfully for at least a decade.	
OUTPUT (Reports, Papers, & etc)	
WORKSHOPS AND PRESENTATIONS	
PROJECT STAFF E A Jobbins	
FUNDING ODA Technical Cooperation	

ODA/BRITISH GEOLOGICAL SURVEY**FORM A3****PROJECT COMPLETION FORM****PROJECT NO: 21****TITLE:** MOSQUITIA PROJECT**LOCATIONS:** Honduras**PROJECT SIZE:** 4**DATES:** 1981**COLLABORATING ORGANISATIONS**

Land Resources Development Centre (LRDC)
Crown Agents
Overseas Development Administration

PROJECT OBJECTIVES

To report on the possible mineral potential of the Mosquitia region of Honduras (east of 85°30'W) the area is heavily forested and poorly understood geologically. (Part of a multi-disciplinary, natural and renewable resources survey for development of Mosquitia).

PROJECT RESULTS

The general geological framework of the area was revised and recommendations made on the nature of a detailed follow-up programme that is essential to establish mineral potential.

Proposals made for a UNDP - or ODA-funded mineral exploration/photogeology/remote sensing programme and the establishment of alluvial-gold co-operatives.

OUTPUT (Reports, Papers, & etc)

Baldock, J W. 1981. Geology and Mineral Resources of the Mosquitia region, Honduras.

(Unpublished BGS report - subsequently included in the 2 volume LRDC/ODA/Crown Agents report).

WORKSHOPS AND PRESENTATIONS

PROJECT STAFF

Dr J W Baldock

FUNDING ODA Technical Cooperation

ODA/BRITISH GEOLOGICAL SURVEY**FORM A3****PROJECT COMPLETION FORM****PROJECT NO: 22****TITLE:** HYDROGEOLOGY OF INTERMONTANE BASINS**LOCATIONS:** Honduras**PROJECT SIZE:** 4**DATES:** 1982-84**COLLABORATING ORGANISATIONS**

Direccion de Recursos Hidricos
Directorate Hydrological Resources (DRH)

PROJECT OBJECTIVES

Evaluation of groundwater resources for irrigation in several isolated intermontane sedimentary basins.

Quantifying costs involved in developing the resources

PROJECT RESULTS

A hydrogeological and Agro-economic appraisal was undertaken for several basins.

Two were selected for detailed assessment, involving drilling, geophysics.

OUTPUT (Reports, Papers, & etc)

Morris, B C and Carruthers, R, 1983. Cays water supply improvement. Reconnaissance visit to Utila, Bay Islands, Honduras. IGS Report No WD/OS/83/10.

Wright, E P, Trotman, D A and Bodman, P. 1982. Groundwater for agricultural Development in Honduras: Report on Planning Mission. IGS Report No WD/OS/82/2.

WORKSHOPS AND PRESENTATIONS**PROJECT STAFF**

B L Morris

FUNDING ODA Technical Cooperation

ODA/BRITISH GEOLOGICAL SURVEY**FORM A3****PROJECT COMPLETION FORM****PROJECT NO: 23**

TITLE: HYDROGEOLOGICAL ADVISORS	
LOCATIONS: Honduras	PROJECT SIZE: 3
	DATES: 1984-90
COLLABORATING ORGANISATIONS Servicio Autonomo Nacional de Acueducos y Alcantarillados (SANAA)	
PROJECT OBJECTIVES To advise the Honduran Government and SANAA on varied hydrogeological and organizational matters, mainly dealing with the capital, Tegucigalpa.	
PROJECT RESULTS Advice was given on many diverse hydrogeological projects and problems, including the construction of a pipeline linking 16 supply wells to Tegucigalpa, the capital city. Advice was also given on reorganizing the management of groundwater resources and questions related to rural and urban water supply.	
OUTPUT (Reports, Papers, & etc) Carruthers, R M. 1983. Geophysical Surveys in Honduras to assist Groundwater Resource Evaluation Studies. AGU Report No 148. Morris, B L. 1983. Hydrogeological Site Assessments (asesorias cortas) in Honduras Republic Nos 1-4. BGS Technical Report WD/OS/83/16. Morris, B L. 1983. Hydrogeological Site Assessments (asesorias cortas) in Honduras Republic Nos 5-8. BGS Technical Report WD/OS/83/18. Morris, B L. 1983. Hydrogeochemical Investigation at El Coyolar Reservoir, Depto de Comanyagua. Asesoria Corta No 10. Foster, S S D. 1984. Appraisal of Technical Collaboration in Groundwater Resources Evaluation. Honduras. BGS Technical Report WD/OS/84/4. Morris, B L. 1984. Hydrogeological Site Assessments (asesorias cortas) in Honduras Republic No's 9-11. BGS Technical Report WD/OS/84/1.	

Morris, B L. 1984. Technical Reports on Potable Water Supply Augmentation for Tegucigalpa using Groundwater Sources. Volume I - Evaluation of existing data in the Amarateca and Rio Hondo areas with preliminary assessment of their potential. BGS Technical Report WD/OS/84/5.

Morris, B L. 1984. Technical Reports on Potable Water Supply Augmentation for Tegucigalpa using Groundwater Sources. Volume II - Evaluation of data in the area of San Juan de Flores and the San Juancito Mountains. BGS Technical Report WD/OS/84/8.

Foster, S S D. 1985. Groundwater for the Tegucigalpa DC-Honduras Water-Supply Master Plan: an assessment of current British support to SANAA and future needs. BGS Technical Report WD/OS/85/6.

Morris, B L. 1985. Hydrogeological Site Assessments in Honduras Republic No's 12 and 13. BGS Technical Report WD/OS/85/9.

Morris, B L. 1985. Technical Reports on Potable Water Supply Augmentation for Tegucigalpa using groundwater sources. Vol III Preliminary Evaluation of Groundwater Chemistry in Tegucigalpa City Area. BGS Technical Report WD/OS/85/10.

Morris, B L. 1985. Technical Reports on Potable Water Supply Augmentation for Tegucigalpa using groundwater sources. Vol IV Report on chemical sampling of groundwater in Amarateca Valley. BGS Technical Report WD/OS/85/11.

Morris, B L. 1985. Technical Reports on Potable Water Supply Augmentation for Tegucigalpa using groundwater sources. Vol V: Water quality and heavy metal contamination risk assessment of the San Juancito Mountain offtakes. BGS Technical Report WD/OS/85/14.

Morris, B L. 1985. Public water supply for 2 slum districts in Tegucigalpa DC under the ODA Small Projects Scheme - Asesorias Cortas No's 14 and 15. BGS Technical Report WD/OS/85/15.

Morris, B L and Sagastume, M. 1987. Groundwater in Tegucigalpa DC Vol 3 - Production reports for the 4 upper sites to supply the Rio Chiquito Valley groundwater pipeline. BGS Technical Report WD/OS/87/17.

Morris, B L and Sagastume, M, 1987. Groundwater in Tegucigalpa DC Vol 1 - Wells of the Padre Miguel Group volcanic aquifer. BGS Technical Report WD/OS/87/10.

Morris, B L and Sagastume, M. 1988. Groundwater in Tegucigalpa DC Vol 4 - Production reports for the Central Hospital Complex and Col Hato de Enmedio sites. BGS Technical Report WD/88/10.

Morris, B L and Sagastume, M. 1988. Groundwater in Tegucigalpa DC Vol 5 - Production reports for the Institute Luis Bogran and Col Rio Grande Sur sites. BGS Technical Report WD/88/15.

BGS. 1988. Groundwater in Tegucigalpa DC Vol 4 - production reports for the Central Hospital Complex and Col Hato de Enmedio sites. BGS Technical Report, WD/88/10.

Marks, R J. 1988. Two reports on the development of water sources in Santa Rosa de Copan. BGS Technical Report WD/88/34R.

Marks, R J. 1988. Potential for further groundwater development in Talanga, Fransisco Morizan. BGS Technical Report WD/88/35R.

WORKSHOPS AND PRESENTATIONS

International Workshop on Groundwater Chemistry, Tegucigalpa, Honduras 1990

PROJECT STAFF

R J Marks
B L Morris

FUNDING ODA Technical Cooperation

ODA/BRITISH GEOLOGICAL SURVEY**FORM A3****PROJECT COMPLETION FORM****PROJECT NO: 24****TITLE:** GEOPHYSICAL STUDY FOR MINERALS, YUSCARAN**LOCATIONS:** Honduras**PROJECT SIZE:** 5**DATES:** 1986**COLLABORATING ORGANISATIONS****PROJECT OBJECTIVES**

To investigate the further potential of a precious/base-metal prospect in rugged terrain, at Yuscaran, Southern Honduras.

The study forms part of UNRFNRE Mineral Exploration Project.

PROJECT RESULTS

Magnetic, electromagnetic and induced polarization (IP) measurements were initially made over known mineralization at Yuscaran, southern Honduras. IP was found to be the only method to give a positive response related to the mineralization and so was selected as the geophysical method for a more extensive survey at Yuscaran.

A large number of chargeability anomalies were found and were often associated with a resistivity anomaly of high values. Several east-north east trends and an east west trend have been identified. Some anomalies have also been found over the unmineralized tuffs and may be related to mineralization in the underlying andesites. The sources of the anomalies are either thin steeply dipping linear zones or more extensive areas of silicification and propylitisation.

Based upon the IP results 11 sites have been recommended for drill holes. The anomalies are caused by disseminated sulphides and it is not possible to ascertain from the IP data whether precious metals are associated with the base metals.

OUTPUT (Reports, Papers, & etc)

Busby, J P and Walker, A S D. 1986. Geophysical Exploration for precious and base metals at Yuscaran Honduras. BGS Regional Geophysics Research Group Report 86/18.

WORKSHOPS AND PRESENTATIONS
PROJECT STAFF J P Busby A S D Walker
FUNDING UN Revolving Fund for Natural Resources Exploration (UNRFNRE)

ODA/BRITISH GEOLOGICAL SURVEY**FORM A3****PROJECT COMPLETION FORM****PROJECT NO: 25**

TITLE: GROUNDWATER INVESTIGATION AND DEVELOPMENT	
LOCATIONS: Honduras	PROJECT SIZE: 3 DATES: 1988-1995
COLLABORATING ORGANISATIONS Servicio Autonomo Nacional de Acueducos y Alcantarillados (SANAA)	
PROJECT OBJECTIVES To advise the Honduranian Government and SANAA on varied hydrogeological and organizational matters, mainly areas outside the capital city.	
PROJECT RESULTS Hydrogeological studies investigating individual proposals for groundwater developrment in Honduras. Hydrogeological assessments of well drilling and pump tests within Honduras, <u>Development of a groundwater database for Honduras.</u>	
OUTPUT (Reports, Papers, & etc)	
WORKSHOPS AND PRESENTATIONS	
PROJECT STAFF A A Mackenzie D F Ball	
FUNDING ODA Technical Cooperation	

ODABRITISH GEOLOGICAL SURVEY**FORM A3****PROJECT COMPLETION FORM****PROJECT NO: 26****TITLE:** VOLCANOLOGICAL RESEARCH AND TRAINING**LOCATIONS:** Mexico**PROJECT SIZE:** 3**DATES:** 1971-4**COLLABORATING ORGANISATIONS**

Instituto de Geologia, Universidad Nacional Autonoma de Mexico
Departamento de Prehistoria, Instituto Nacional de Antropologia e Historia

PROJECT OBJECTIVES

To provide advice and training in mineralogy, petrology and geochemistry at the National University and to the Mexican Government.

To stimulate volcanological research in Mexico and train counterpart geologists.

To supervise post-graduate research students.

PROJECT RESULTS

A volcanic studies group was set up.

A detailed study of the development of the Nevado de Toluca volcano was undertaken, a 1:100 000 geological map of the area was published.

Upto 12 post-graduate research students were supervised.

A study of Popocatepetl Volcano was also mounted.

OUTPUT (Reports, Papers, & etc)

Bloomfield, K. 1973. Focus on the Nevado de Toluca. Intercambio Mexico City, No 350, Feb 1973, pp 51-56.

Bloomfield, K. 1973. The age and significance of the Tenango Basalt, central Mexico. Bulletin Volcanology, Vol 37, pp 586-595.

Bloomfield, K and Cepeda-Davila, L. 1973. Oligocene alkaline igneous activity in NE Mexico. Geological Magazine, Vol 110, pp 551-555.

Bloomfield, K and Valastro, S Jr. 1974. Late Pleistocene eruptive history of Nevado de Toluca volcano, central Mexico. Bulletin Geological Society America, Vol 85, pp 901-906.

Bloomfield, K and Valastro, S Jr. 1977. Late Quaternary tephrochronology of Nevado de Toluca volcano, central Mexico. IGS Overseas Geology and Mineral Resources, No 46, 15 pp.

Bloomfield, K, with Whitford, D J. 1976. Geochemistry of late Cenozoic volcanic rocks from the Nevado de Toluca area, Mexico. Carnegie Institute Washington Yearbook 1975, pp 207-213.

Bloomfield, K, Sanchez Rubio, G and Wilson, L. 1977. Plinian eruptions of Nevado de Toluca volcano, Mexico. Geologisches Rundschau, Band 66, Heft 1, pp 120-145.

WORKSHOPS AND PRESENTATIONS**PROJECT STAFF**

Dr K Bloomfield

FUNDING ODA Technical Cooperation

TITLE: CERRO PANDO GEOTHERMAL FIELD**LOCATIONS:** Panama**PROJECT SIZE:** 4**DATES:** 1977-81**COLLABORATING ORGANISATIONS**

Corporación de Desarrollo Minero Cerro Colorado (CODEMIN)

PROJECT OBJECTIVES

Investigation of the Cerro Pando Geothermal area, Western Panama involving geological mapping, remote sensing, geophysical, geochemical and hydrogeological studies to detect zones of active faults around the geothermal system, which may act as pathways for the migration of thermal groundwaters.

PROJECT RESULTS

Detailed geological mapping of 500 km² involving aerial photography and satellite imagery interpretation together with geophysics (microseismic survey) and temperature, conductivity and chemical analyses of streams and springs show the geothermal zone is more extensive than previously known, the hot springs are controlled by intersecting faults that cut the local Tertiary volcanic rocks, there is no active volcanicity in the area.

Hydrothermal mineralogy from deep drill cores indicates a former higher temperature geothermal regime.

Recommendations were made to concentrate further exploration in the area immediately to the north since deep thermal waters were detected migrating southwards into the area.

OUTPUT (Reports, Papers, & etc)

Wright, E P and Williamson, K H, 1976. An assessment of the Cerro Pando geothermal project. Interim report to CODEMIN. IGS Report No WD/OS/76/14.

Forster, A. 1977. Density, porosity, magnetic susceptibility and resistivity determinations on nine rock samples from Panama. IGS-Engineering Geology Unit Report 106.

Forster, A. 1977. Density, porosity, sonic velocity, magnetic susceptibility and resistivity determinations on a sandstone sample from Panama. IGS-Engineering Geology Unit Report 116.

Lee, M K and Parker, M E. 1977. Electrical, magnetic and radiometric surveys for geothermal resources in the Cerro Pando area of Panama. IGS, Applied Geophysics Unit Report 50.

Mortimer, C. 1977. State of geothermal investigations in the Cerro Pando geothermal area, Chiriqui Province, Panama. IGS Overseas Division Report 77/17.

Mortimer, C. 1977. Preliminary study of microseismic activity in the Cerro Pando geothermal area, Panama. IGS Overseas Division Report 77/18.

Williamson, K H. 1977. Airborne infra-red survey: discussion of application in Cerro Pando Geothermal area, Panama. IGS Report No WD/OS/77/11.

Williamson, K H. 1977. Microearthquakes, geothermal prospecting tool for Cerro Pando, Panama. IGS Report No WD/OS/77/10.

Bath, A H. 1978. A re-assessment of chemical data from the geothermal area of Cerro Pando, Panama. IGS Report No WD/OS/78/3.

Bath, A H. 1978. Geothermal exploration of the Republic of Panama; report on hydrochemical technique. IGS Report No WD/OS/78/13.

Browitt, C W A. 1978. Plan for Microearthquake survey - Chiriqui, Panama. IGS Global Seismology Unit report no 97.

Thomas, L P. 1978. Republic of Panama Geothermal Project, February-May 1978. IGS Overseas Division Occasional report series BF9.

Williamson, K H. 1978. Panama Geothermal Project: heat flow and river/spring sampling programmes. IGS Report No WD/OS/78/23.

Williamson, K H. 1978. Panama Geothermal Project: progress report, July 1978. IGS Report No WD/OS/78/33.

Mortimer, C and Stewart, R H. 1980. Extended geological observations on the Cerro Pando geothermal project area. IGS Overseas Division Report 80/3.

Williamson, K H. 1981. A reconnaissance exploration programme for geothermal resources in Cerro Pando, Panama. Summary Report. IGS Report No WD/OS/81/2.

Williamson, K H. 1981. Cerro Pando Geothermal Project. Report on a brief visit 24-28 February 1981. IGS Report No WD/OS/81/12.

Williamson, K H. 1981. Analysis of microearthquake data from Cerro Pando, Panama.

WORKSHOPS AND PRESENTATIONS

PROJECT STAFF

Dr C Mortimer OBE
Dr E P Wright
Dr K H Williamson
Dr M K Lee
M E Parker
P G Greenwood
C W A Browitt
A Forster
Dr A H Bath

FUNDING ODA Technical Cooperation

ODA/BRITISH GEOLOGICAL SURVEY**FORM A3****PROJECT COMPLETION FORM****PROJECT NO: 28**

TITLE: GEOLOGY OF THE WESTERN CORDILLERA	
LOCATIONS: Peru	PROJECT SIZE: 1 DATES: 1963-71
COLLABORATING ORGANISATIONS Comision Carta Geologica Nacional (to 1967) Servicio Nacional de Investigacion y Fomento Mineros (from 1967)	
PROJECT OBJECTIVES Geological mapping, principally of the Pacific coastal belt of Peru. Training counterpart staff in geological mapping and laboratory techniques, installation of ODA-donated equipment. Geochemical and field studies to identify zones of mineralization.	
PROJECT RESULTS Photogeological and regional geological map at 1:100 000 of 48¼° sheets, an area of approximately 130,000 km² was accomplished. A geochemical survey of Northern Peru was undertaken and disclosed several areas of potential commercial interest including several porphyry copper ore-bodies. Considerable effort was put into training counterpart staff in geological mapping and operation of ODA donated laboratory equipment, several training awards for UK study were also made. Advice on hydrogeology, mining and engineering geology was provided for a number of civil engineering Projects.	

OUTPUT (Reports, Papers, & etc)

Maps, 48 1:100 000 scale maps each covering a ¼° sheet (130.000 km² in all).

Wilson, J J. 1963. Cretaceous stratigraphy of central Andes of Peru. Bulletin American Association Petroleum Geologists, Vol 47, pp 1-34.

Wilson, J J and Garcia, W. 1963. Geologica de los cudrángulos de Pachia y Palca.

Wilson, J J and Reyes, L. 1964. Geologia del cuadrángulo de Pataz. [Geology of the Pataz quadrangle]. Boletin Comision Carta Geologica Nacional Peru, Vol 9, 91 pp.

Wilson, J J and Garayar, 7. 1967. Geologia de los cuadrángulos de Mollebamba, Tayabamba, Huaylas, Pomabamba, Carhuaz y Huari. [Geology of the Mollebamba, Tayabamba, Huaylas, Pomabamba, Carhuaz and Huari quadrangles.] Boletin Servicio Geologica y Minería Peru, Vol 16, 95 pp.

Hutchison, D and Stacey, F R. 1968. Analysis of mineralised rocks from Peru. IGS Analytical Chemistry Unit, Report No 11, 1p.

Prewett, W G. 1968. Chemical analysis of igneous rocks from Peru. IGS Analytical Chemistry Unit, Report No 15, 2pp.

Stewart, J W. 1968. In Geologia de los cuadrángulos de Mollendo y La Joya. [Geology of the Mollendo and La Joya quadrangles.] Boletin Servicio Geologica y Minería Peru, Vol 19, 93 pp.

Roberts, J L. 1969. Results of the examination of geochemical prospecting samples from Peru. IGS Analytical Chemistry Unit, Report No 44, 14pp.

Prewett, W G. 1970. Chemical analysis of igneous rocks from the coastal Batholith, Peru, IGS Analytical Chemistry Unit, Report No 59, 2pp.

Snelling, N J and Stewart, J. 1970. Rb:Sr age determinations on rocks and minerals from the Peruvian Coastal batholith. IGS Isotope Geology Unit, Report No 70/1, 3pp.

Snelling, N J and others, 1970. K:Ar determinations on micas from the metamorphic rocks of the preMesozoic basement, southern Peru. IGS Isotope Geology Unit, Report No 70/16, 2pp.

Cobbing, E 7. 1972. Tectonics elements of Peru and evolution of the Andes. 24th Session, International Geological Congress, Canada 1972, Section 3.

Stewart, J W and Evernden, J F. 1972. Age determinations from Peru and their significance: a reconnaissance survey. IGS Isotope Geology Unit, Report No 72/8, 3pp.

Ozard, J M. 1973. K:Ar age determinations on samples from Peru. IGS Isotope Geology Unit, Report No 73/8, 5pp.

Stewart, J W, Evernden, J F and Snelling, N J. 1974. Age determinations from Andean Peru: a reconnaissance survey. Geological Society of America Bulletin, Vol 85 pp 1107-1116.

Wilson, J J. In press. Geologica de los cuadrangulos de Pacasmayo, Chepen, Chiclayo, Chongoyape, Chota, Jayanca, Pucahuasi y Cutervo. Boletin Instituto Geologica, Minería Metallurgia, Peru.

Cobbing, E J, Pitcher, W S, Wilson, J J, Baldock, J U, Taylor, W P, McCourt, W, and Snelling, N J. 1981. The geology of the western cordillera of Northern Peru, IGS Overseas Memoir No 5.

WORKSHOPS AND PRESENTATIONS

International Geological Congress, Montreal, Canada 1972

PROJECT STAFF

Dr J J Wilson (Project Manager)

Dr B J Amos

Dr J W Baldock

Dr J H Bean

Dr E J Cobbing

Dr F J Sawkins

Dr J W Stewart

R B Evans

P G Greenwood

J E G W Greenwood

FUNDING ODA Technical Cooperation

ODABRITISH GEOLOGICAL SURVEY**FORM A3****PROJECT COMPLETION FORM****PROJECT NO: 29****TITLE:** COASTAL BATHOLITH RESEARCH**LOCATIONS:** Peru**PROJECT SIZE:** 3**DATES:** 1973-80**COLLABORATING ORGANISATIONS**

Geology Department, University of Liverpool
Instituto de Geologia y Minería del Perú

PROJECT OBJECTIVES

Contribution of specialist to Liverpool University's ODA-funded research on the Coastal Batholith of Peru.

PROJECT RESULTS

Significant Advances in understanding of the origin, mineralization and tectonics of batholiths resulted from this study.

The scientific papers produced including those contributed to by the BGS specialist (Dr E J Cobbing) are detailed overleaf.

OUTPUT (Reports, Papers, & etc)

Cobbing, E J and Pitcher, W S. 1972. The Coastal Batholith of central Peru. *Journal Geological Society London*, Vol 128, pp 421-460.

Cobbing, E J. 1972. Plate tectonics and the Peruvian Andes. *Nature*, Vol 240 pp 51-53.

Bussell, M A, Pitcher, W S and Wilson, P A. 1976. Ring complexes of the Peruvian Coastal Batholith: a long standing sub-volcanic regime. *Canadian Journal of Earth Science*, 13, 1020-30.

Cobbing, E J. 1976. The geosynclinal pair at the continental margin of Peru. *Tectonophysics*, Vol 36, pp 157-165.

Bussell, M A and McCourt, W J. 1977. The Iglesia Irca Intrusion and the role of gas brecciation in the emplacement of the Coastal Batholith of Peru. *Geological Magazine* 114, 375-87.

Cobbing, E J, Ozard, J M and Snelling, N J. 1977. Reconnaissance geochronology of the crystalline basement rocks of the Coastal Cordillera of southern Peru. *Bulletin Geological Society America*, Vol 88, pp 241-246.

Cobbing, E J, Pitcher, W S and Taylor, W P. 1977. Segments and Super-units in the Coastal Batholith of Peru. *Journal Geology*, Vol 85, pp 625-631.

Cobbing, E J. 1978. The Andean geosyncline in Peru, and its distinction from Alpine geosynclines. *Journal Geological Society London*, Vol 135, pp 207-218.

McCourt, W J, with Atherton, M P, Sanderson, L M and Taylor, X X. 1979. The geochemical character of the segmented Peruvian Coastal Batholith and associated volcanics. In Atherton, M P and Tarney, J (editors). *Origin of granite batholiths: geochemical evidence*. pp 45-64. (Orpington, Kent: Shiva Publishing Ltd).

Cobbing, E J and Pitcher, W S. 1979. El Batholito Costanero en la parte central de Peru [The Coastal Batholith in Central Peru]. *Boletin del Instituto de Geologia Mineria Metalurgia, Peru, Serie D. Estudio Especial No 7* pp 1-40. [In Spanish].

Cobbing, E J, Pitcher, W S, Wilson, J J, Baldock, J W, Taylor, W P, McCourt, W and Snelling, N J. 1981. The geology of the western Cordillera of northern Peru. *IGS Overseas Memoir No 5*.

McCourt, W J. 1981. The geochemistry and petrography of the Coastal Batholith of Peru, Lima segment. *Journal of the Geological Society of London*, Vol 138, pp 407-420.

Cobbing, E J, Wilson, J J, Baldock, J W, Taylor, W P, McCourt, W J and Snelling, N J. 1981. Estudio Geologico de la Cordillera Occidental del norte del Peru. *Boletin del Instituto de Geologia Mineria Metalurgia, Serie D, Estudio Especial, Vol 10*, p 252.

Bussell, M A. 1983. Crystallization history of granophyric intrusives from the Peruvian Coastal Batholith. *Lithos* 16, 169-84.

Beckinsale, R D, Sanchez-Fernandez, A W, Brook, M, Cobbing, E J, Taylor, W P and Moore, N D. 1985. Rb-Sr whole-rock isochron and K-Ar age determinations for the Coastal Batholith of Peru. In *Magmatism at a Plate Edge*. Wiley and Sons p 177-202.

Bussell, M A and Wilson, C D V. 1985. A gravity traverse across the Coastal Batholith of Peru. *Journal Geological Society of London* 142, 633-41.

Cobbing, E J. 1985. The tectonic setting of the Peruvian Andes In Magmatism at a Plate Edge. Wiley & Sons P 3-12.

Magmatism at a Plate Edge: The Peruvian Andes 1985. Eds W S Pitcher, M P Atherton, E J Cobbing and R D Beckinsale.

Cobbing, E J. 1987. A comparison of the Andean Batholith in Peru with granites from the Southeast Asia Tin Belt. Proceedings of the Ussher Society, Vol 6 pp 423-430.

Bussell, M A. 1988. Structure and petrogenesis of a mixed-magma ring dyke in the Peruvian Coastal Batholith: eruptions from a zonal magma chamber. Transactions of the Royal Society of Edinburgh: Earth Sciences, 79, 87-104.

WORKSHOPS AND PRESENTATIONS

PROJECT STAFF

Dr E J Cobbing

FUNDING ODA Technical Cooperation

ODA/BRITISH GEOLOGICAL SURVEY**FORM A3****PROJECT COMPLETION FORM****PROJECT NO: 30****TITLE:** MINERAL EXPLORATION, CORDILLERAS HUAYHUASH AND BLANCA**LOCATIONS:** Peru**PROJECT SIZE:** 3**DATES:** 1977-82**COLLABORATING ORGANISATIONS**

Direccion de Geologia Minera, Instituto Geologico Minero y Metalurgico, Peru

PROJECT OBJECTIVES

Geochemical exploration and mineral prospection of about 6,300 km² of the eastern flanks of the Cordillera Huayhuash and Cordillera Blanca, North-Central Peru.

This study is a more detailed follow-up of potential mineralization indicated by Project 28 (this volume).

On job training of Counterpart staff

PROJECT RESULTS

Molybdenum-rich anomalies were revealed by geochemical exploration north west of Huari, follow-up field investigations located important molybdenite bearing stockwork mineralization in the contact zone of the batholith (sampling, detailed mapping) Molybdenum is a rare strategic metal used mainly in high specification types of steel.

Disseminated stratabound sulphide mineralization was located in the Chimú Formation SSE of Chavin de Huantar.

Numerous polymetallic sulphide vein occurrences and geochemical anomalies discovered and selected preliminary follow-up studies undertaken.

OUTPUT (Reports, Papers, & etc)

Bennett, J D, Lynas, B D T and Rogers, P J. 1981, Project Huayhuash: Final Report. Instituto Geologico Minero y Metalurgico, Lima Peru 61 p 1 Map.

Bennett, J D, Rogers, P J and Lynas, B D T. 1981. Project Huayhuash: provisional report, regional phase. British-Peruvian Technical Cooperation, INGEMMET, Lima. [Unpublished report.]

Bennett, J D and Lynas, B D T. 1981. The Jacabamba molybdenum prospect. British-Peruvian Technical Cooperation, INGEMMET, Lima. [Unpublished report. 2 Volumes]

Lynas, B D T and Bennett, J D. 1983. Jacabamba molybdenum prospect, Ancash, Peru. Transactions of the Institution of Mining and Metallurgy, Vol 92, pp B42-45.

WORKSHOPS AND PRESENTATIONS**PROJECT STAFF**

Dr J D Bennett (Project Manager)
Dr B D T Lynas
Dr P J Rogers

FUNDING ODA Technical Cooperation

ODABRITISH GEOLOGICAL SURVEY**FORM A3****PROJECT COMPLETION FORM****PROJECT NO: 31****TITLE:** GEOLOGY OF THE PUNO REGION**LOCATIONS:** Peru**PROJECT SIZE:** 3**DATES:** 1982-6**COLLABORATING ORGANISATIONS**

Instituto Geologico Minero y Metalúrgico (INGEMMET) Lima

PROJECT OBJECTIVES

Geological mapping programme of 36.000 km² of southern Peru west of Lake Titicaca, the area was thought to have geothermal and metallic mineral potential.

PROJECT RESULTS

The Geological Surveying of the area was accomplished, detailed geological maps and a regional summary map were produced.

Polymetallic deposits have been identified in the area and low grade copper mineralization was identified in the Tacaza Group volcanics which are Tertiary in age. The geothermal potential of the area has also been examined.

A new regional stratigraphical and structural synthesis of the area has emerged detailing seven distinct deformation events in the evolution of this sector of the Andes, this model has widespread application to much of central and south Peru.

OUTPUT (Reports, Papers, & etc)

15 1:100 000 ¼° sheets were produced covering the area together with accompanying geological notes
1 1:500 000 regional summary geological map

Ellison, R A. 1985. Nueves aspectco de la estratigraffa Cretácia en la region del lago Titicaca del sur de Perú. Boletin de la Sociedad Geologica de Peru Vol 75, 51-63.

Klinck, B A. Ellison, R A and Hawkins, M P. 1986. The Geology of the Cordillera Occidental and Alhplano West of Lake Titicaco, Southern Peru, BGS Report 353p.

Ellison, R A and Palacios, O. 1986. El sistema Cretacica en la region del lago Titicaca. Proceedings of 8th Bolivian Geological Congress, La Paz.

Ellison, R A. 1987. The Andean orogenic cycle in southern Peru. Proceedings of 6th Peruvian Geological Congress Lima, Peru.

Fletcher, C J N, Hawkins, M P and Tejada. 1989. Structural control and genesis of polymetallic deposits in the Altiplano and Western Cordillera of southern Peru. Journal of South American Earth Sciences Vol 2, 61-71.

Ellison, R A, Klinck, B A and Hawkins, M P. 1989. Deformation events in the Andean orogenic cycle in the Altipiano and Western Cordillera, southern Peru. Journal of South American Earth Sciences Vol 2 No 3 263-276.

Ellison, R A. 1990. The geology of the Cordillera Occidental and Altiplano west of Lake Titicaca, southern Peru BGS Overseas Geology and Mineral Resources, No 65.

WORKSHOPS AND PRESENTATIONS

Presentations at:

- a) Andean Workshop, Oxford Polytechnic 1987
- b) South American Geological Congress, Lima, Peru 1987
- c) 8th Bolivian Geological Congress, La Paz, Bolivia 1986 (Contribution to IGCP Project 242)
- d) 6th Peruvian Geological Congress, Lima, Peru 1987

PROJECT STAFF

Dr B Klinck
R A Ellison
M P Hawkins
W Burgess

FUNDING ODA Technical Cooperation

TITLE: GROUNDWATER POLLUTION AND RECHARGE, LIMA	
LOCATIONS: Peru	PROJECT SIZE: 4 DATES: 1984-6
COLLABORATING ORGANISATIONS Servicio de Agua Potable y Alcantarillado de Lima (SEDAPAL) Centro Panamericano de Ingenieria Sanitaria y Ciencias del Ambiente (CEPIS) University of Surrey, UK	
PROJECT OBJECTIVES To investigate the influence of man-made aquifer recharge mechanisms in arid zones especially wastewater reuse at San Juan de Miraflores and la Molina Alta near Lima, on groundwater.	
PROJECT RESULTS It was proven that mains leakage and over irrigation of both amenity areas and farmed land are important aquifer recharge mechanisms and these were quantified. The latter can be by either riverwater or wastewater. The infiltrating wastewater undergoes considerable quality improvements during infiltration but does not reach potable quality even with a 20 m thick unsaturated zone. The residual pollution is largely excessive nitrate concentrations and 'traces of organic carbon, including some chlorinated toxic compounds.	
OUTPUT (Reports, Papers, & etc) Geake, A K and Foster, S S D. 1985. Groundwater pollution threats and artificial recharge prospects in Lima, Peru. BGS Technical Report WD/OS/85/20. Geake, A K and Foster, S S D. 1986. Groundwater recharge controls and pollution pathways in the alluvial aquifer of metropolitan Lima, Peru. BGS Technical Report WD/OS/86/10.	
WORKSHOPS AND PRESENTATIONS	

PROJECT STAFF

Dr S S D Foster

A K Geake

L R Bridge

D J Miles

J M Trafford

W G Darling

R Shearer

D J Wheeler (University of Surrey)

H E Skilton (University of Surrey)

FUNDING ODA, Pan-American Health Organisation {PAHO}

ODA/BRITISH GEOLOGICAL SURVEY**FORM A3****PROJECT COMPLETION FORM****PROJECT NO: 33****TITLE:** GEOPHYSICAL STUDY, ANANEA GOLD CONCESSION**LOCATIONS:** Peru**PROJECT SIZE:** 5**DATES:** 1985**COLLABORATING ORGANISATIONS**

Minero, Peru

PROJECT OBJECTIVES

To conduct a resistivity survey over the Ananea concession to determine the thickness and extend of the gold bearing moraine formation.

The study forms part of a United Nations backed mineral exploration survey in southern Peru.

PROJECT RESULTS

Resistivity, gravity and altimeter measurements were taken over the 300 km² concession detecting the important physical characteristics of the glacial deposits.

The variations in thickness of the gold-bearing moraines were mapped by electrical soundings and confirmed by drilling; the gravity data indicate important variations in the structure of the drift deposits which are likely to relate to their gold potential.

The studies proved useful in guiding the extensive and expensive UNRFNRE drilling programme for gold.

OUTPUT (Reports, Papers, & etc)

Busby, J P and Evans, R B. 1985. Geophysical Surveys for auriferous moraine thicknesses in the Ananea Concession, south-eastern Peru. BGS Regional Geophysics Research Group Report 85/8.

WORKSHOPS AND PRESENTATIONS

Demonstrations of resistivity surveying to UN and Minero Peru staff.

PROJECT STAFF

R B Evans
J P Busby

FUNDING United Nations Revolving Fund For Natural Resources Exploration (UNRFNRE)

ODABRITISH GEOLOGICAL SURVEY**FORM A3****PROJECT COMPLETION FORM****PROJECT NO: 34****TITLE:** PERUVIAN COAL STUDIES**LOCATIONS:** PERU**PROJECT SIZE:** 5**DATES:** 1984**COLLABORATING ORGANISATIONS**

PROCARBON, Peru

PROJECT OBJECTIVES

In response to a request from ODA a short consulting visit was made to Peru to assist PROCARBON in the assessment of the proven, probable and possible coal reserves of Peru.

To comment on the quality of the coals present and whether they met international specifications.

PROJECT RESULTS

The following conclusions and recommendations were reported

Peru possess at least 1.000 million tonnes of coal resources, present data are insufficient to define reserves or targets for extraction

The following 4 stage investigation is needed

- a) Collation of existing data
- b) Assessment of local markets
- c) Geological Survey of Coalfields
- d) Identification and exploration of targets identified

OUTPUT (Reports, Papers, & etc)

Burgess, I C. 1985. Peruvian Coal Studies, BGS Overseas Directorate Report 85/1.

WORKSHOPS AND PRESENTATIONS
PROJECT STAFF Dr I C Burgess
FUNDING ODA Technical Cooperation

ODABRITISH GEOLOGICAL SURVEY**FORM A3****PROJECT COMPLETION FORM****PROJECT NO: 35**

TITLE: GEOPHYSICAL SURVEY OF THE VALENTINES IRON DEPOSITS	
LOCATIONS: Uruguay	PROJECT SIZE: 5 DATES: 1975
COLLABORATING ORGANISATIONS	
PROJECT OBJECTIVES A Geophysicist contributed to this UNDP study in Northern Uruguay. The objective was to identify and trace magnetic anomalies related to the Iron deposits and to train counterpart Uruguayan staff.	
PROJECT RESULTS The geophysical study revealed large magnetic anomalies associated with the iron deposit and identified extensions of it. The work enabled targets for drilling to be identified. One counterpart geologist subsequently became a geophysicist.	
OUTPUT (Reports, Papers, & etc) Confidential Report to UNDP	
WORKSHOPS AND PRESENTATIONS Presentation to Uruguayan Government officials in Montevideo	
PROJECT STAFF R B Evans	
FUNDING United Nations Development Programme (UNDP)	

ODABRITISH GEOLOGICAL SURVEY**FORM A3****PROJECT COMPLETION FORM****PROJECT NO: 36**

TITLE: THE MANAUS-GEORGETOWN HOVERCRAFT EXPEDITION	
LOCATIONS: Brazil and Guyana	PROJECT SIZE: 5 DATES: 1971
COLLABORATING ORGANISATIONS British Broadcasting Corporation Cushioncraft Ltd, UK Department of Trade and Industry	
PROJECT OBJECTIVES The main purpose was to make a TV feature film for "The World About Us" series of the first journey by hovercraft from Manaus (Brazil) to Georgetown (Guyana). A subsidiary object was to demonstrate the ability of a new type of hovercraft - Cushioncraft CC7" - under varied conditions thereby promoting sales of a British invention/manufacture.	
PROJECT RESULTS After trials and demonstrations on the Amazon around Manaus hovercraft successfully made the 900 mile river/overland journey to Georgetown. The route was: Rio Negro - Rio Branco Rio Takutu - overland across N Savannas in Guyana to Rupununi River - Essequito River to mouth Caribbean Sea to Georgetown.	
OUTPUT (Reports, Papers, & etc) Berrangé, J P. 1971. The Amazon-Georgetown Hovercraft Expedition. IGS Overseas Division, Report No 45, unpublished.	
WORKSHOPS AND PRESENTATIONS "The Forbidden Route" - full length feature film shown on TV as part of BBCs "World About Us" series.	

PROJECT STAFF

Mr R L W Saunders	- Leader/Producer	- BBC TV
Mr A Morrison	- Cameraman	- BBC TV
Mr P Smith	- Sound Recordist	- BBC TV
Capt C A Tomlinson	- Pilot	- Cushioncraft Ltd
Mr L Christophers	- Engineer	- Cushioncraft Ltd
Dr J P Berrangé	- Navigator/Consultant	- Institute of Geological Sciences

FUNDING ODA Technical Cooperation