BRGM

L'ENTREPRISE AU SERVICE DE LA TERRE

Stratégie du BGS et collaboration BGS-BRGM

Compte rendu de la visite du 9 au 12.07.1990

G. Sustrac

Juillet 1990
R 31 185
(DS n° 293)

BRGM
DIRECTION SCIENTIFIQUE
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Une première visite globale au BGS ainsi qu'à d'autres organismes de Grande Bretagne a été faite du 13 au 20 juin 1988(1). Cette visite a été complétée par un contact avec l'Overseas Development Institute (ODI) et l'Overseas Development National Resources Institute (ODNRI) le 15-12-1989(2).

Par ailleurs le BGS a été associé au BRGM dans une action CCE pour l'étude et la mise au point d'une méthode de prospection géochimique par les gaz des sols (MSM 042 F, 1/1983 - 6/1985) et il l'est dans deux nouvelles actions, l'une relevant de l'appel d'offres "Matières Premières Minérales" et portant sur l'évaluation combinée de données de prospection multisources(3), l'autre les panaches de pollution autour des décharges(4).

Une action commune est envisagée dans le cadre de STD 3 (DG XII) sur le thème de la recharge des aquifères sableux côtiers du Sénégal en profitant de l'accès constamment renouvellé à la zone non saturée dans l'exploitation de phosphates de Taïba(5).

Le nouvel organigramme du BGS est donné dans la figure 1.

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(1) DS n° 53 du 20.02.1989.

(2) DS n° 26 du 1.02.1990.

(3) MIDAS "Multidatasets analysis for the development of metallogenic and economic models and exploration criteria for gold deposits in Western Europe". BGS chef de projet.

(4) Factors controlling the migration and attenuation of priority pollutants in landfill pollution plumes.

(5) Contact J.J. COLLIN, M. EDMONDS du BGS.

Organisation of the British Geological Survey, May 1990

ANNEX A

DIRECTOR Dr P J Cook

PROGRAMMES

Land & Marine Surveys (N)	Land & Marine Surveys (S)	Overseas	Geophysics & Hydrocarbons	Geochemistry & Hydrogeology	Information & Marketing
Mr J H Hull	Dr P M Allen	Dr A J Reedman	Dr R T Haworth (1)	Dr J D Mather (1)	~~Dr B Kelk~~ Dr. D. SLATER
Highlands & Islands Dr D I J Mallick	Central England Mr J I Chisholm	Africa and the Middle East Dr R L Johnson	Geomagnetism Dr W F Stuart	Applied Geochemistry Dr J A Plant	Business Development Dr B G N Page*
Central Scotland Dr A J Wadge	Eastern England Dr R G Thurrell	Asia and Latin America Dr J D Bennett*	Seismology Dr C W A Browitt	Fluid Processes Dr A H Bath	Public Relations
Southern Scotland & Northern England Dr D J Fettes	South-Western England Dr R W Gallois	Pacific Dr B G N Page	Hydrocarbons Mr M J Dean*	Hydrogeology Dr S S D Foster	Information Systems Vacancy
Northern Ireland Mr A E Griffith	Wales Dr R A Bazley	Overseas Hydrogeology Dr R Herbert			Mineral Intelligence ~~Dr D Slater~~ R. CROCKETT
Marine Surveys (N) Mr D A Ardus	Marine Surveys (S) Dr C D R Evans	Mining Adviser Mr P G Walduck			National Geosciences Data Centre Mr J A Bain
Marine Operations Dr A Dobinson					Library

Chief Geologist Dr P M Allen	Engineering Geology Mr M G Culshaw	Stratigraphy & Tectonics Dr A Whittaker Biostratigraphy; Sedimentology; Seismo-stratigraphy	Dr M F Howells *Volcanology* Dr B Owens *Palynology*	Publication Services Dr T J Dhonau Book Production Cartographic Production N Cartographic Production S Cartographic Development Photography Reprography
Chief Geophysicist Dr R T Haworth (1)	Regional Geophysics Dr D M McCann	Remote Sensing & Image Analysis Dr D Greenbaum	Dr S Crampin *Seismic Anisotropy*	
Chief Geochemist Dr J D Mather (1)	Analytical Geochemistry Mr D L Miles	Mineral Sciences Dr I R Basham	Dr W M Edmunds *Hydrogeochemistry* Dr T J Shepherd *Fluid Inclusions*	

Individual Merit

Administration D Hackett (*Secretary*)

(1) Départ prévu du BGS en 1990

* Acting Head

FIGURE 1

1 - GESTION DES DONNÉES DU SOUS-SOL ET CARTOGRAPHIE THÉMATIQUE

1.1 - BANQUES DE DONNÉES

La position du BGS est de laisser les banques de données séparées mais d'établir un référentiel d'accès. Ce référentiel concerne en particulier :

1 - les données de sondages,
2 - les rapports de travaux par des sociétés extérieures (site investigation reports),
3 - les publications du BGS,
4 - les rapports du BGS publics (open file reports).

Une large partie de l'information concernant les sondages et les rapports de travaux de sociétés est fournie au BGS sur une base de volontariat, car la législation n'impose qu'une notification à l'avance des ouvrages de plus de 30 m de profondeur pour l'exploration minérale et plus de 15 m pour les sondages pour eau.

Pour les sondages, le référentiel général comportera :

- n° d'accès,
- dénomination,
- profondeur,
- référence en coordonnées nationales,
- confidentialité - remarques,
- microfilm ou pas,
- lieu de la consultation : Keyworth, Edimbourg, Leeds, Exeter.

A l'interrogation courante sur l'existence et la nature d'ouvrages dans telle région, il peut être répondu par un listing d'informations ou un report sur cartes. Il y a environ 20 000 demandes par an, dont 15 000 correspondant à ce type d'interrogation courante et sont satisfaites dans le cadre du SP du BGS et 5000 impliquant un travail de recherche particulier du BGS, facturé au cas par cas. On trouvera en annexe 1 les barèmes en vigueur.

A ce jour, le référentiel général a été établi pour une partie seulement des quelques 1,2 million de sondages répartis sur l'ensemble du territoire. 150 000 des 230 000 sondages existant à Keyworth et des quelque 500 000 correspondant à l'Angleterre et au Pays de Galles ont été référencés dans la banque. Il reste à entrer les sondages archivés à Newcastle, Exeter, Abersworth ainsi que l'Irlande du Nord et l'Ecosse. De longue date, l'Ecosse a développé son propre système. Toutes ces données sont gérées sous ORACLE.

Le positionnement des sondages est fait selon une numérotation continue par feuille à 1/10 000 découpée en 4 quarts (NW, NE, SW, SE) pour faciliter le repérage. Les indications sur maître d'oeuvre, maître d'ouvrage, sondeur ne sont pas informatisées mais seulement répertoriées dans le fichier manuel.

La gestion des données documentaires est également informatisée. Ceci vaut pour la documentation existant à la bibliothèque du BGS et pour la cartothèque. Cette dernière est gérée en s'appuyant sur le logiciel CARTONET, développé par l'Université d'Edimbourg et qui est devenu le standard national de la British Library. Les cartes sont référencées par leur emplacement sur des canevas géographiques donnant les coordonnées et la localisation à l'intérieur des frontières des pays (cf. annexe 2). Les données alphanumériques sont également digitalisées sous ORACLE.

ORACLE sert également pour la gestion de la carothèque qui dispose actuellement de plus de 3000 sondages correspondant à 150 000 m de carottes. Sont également stockés plus de 3500 échantillons de sondage pris à la main et plus de 500 sondages pour hydrocarbures sous forme de cuttings (> 1 M échantillons). L'entrée annuelle de carottes est de l'ordre de 6000 m mais peut atteindre 12-15 000 m. La carothèque sera pleine à l'an 2000 et le BGS doit envisager, soit une sélection de sondages à conserver, soit une extension de ses bâtiments.

Les cartons de stockage de carotte sont à une dimension de un m standardisée. Le sondage est référencé dans la banque par le n° d'enregistrement du BGS, le nom du sondage et ses coordonnées. D'une façon générale, le choix de conserver un sondage après avoir procédé aux échantillonnages nécessaires est pris à Keyworth, pas sur le terrain. Les gestionnaires de la banque incitent en tout état de cause à ne conserver que la moitié des carottes sauf dans le cas où des essais géotechniques peuvent s'avérer ultérieurement utiles.

Le nombre d'échantillons de géochimie stream sediments stockés n'est pas connu avec précision mais pourrait être de l'ordre de un million. Il apparaît qu'il existe une demande significative des sociétés pour faire de nouvelles analyses d'échantillons anciennement collectés. Ceci vaut en particulier pour les programmes or.

L'accès à la banque est facturée seulement aux sociétés (pas aux universités) : 50 livres/j, 8,5 livres par échantillon et 25 livres par sondage. Un thésard soutenu par une société rentre dans le tarif société.

Une autre composante importante de la stratégie du BGS a été de compenser l'hétérogénéité de l'accès aux banques de données différentes par la mise en place du logiciel MARS (Menu Aided Retrieval System), langage unifié d'accès, qui n'impose pas de sortir du système (annexe 3). La mise en place de ce logiciel répond en fait à un double objectif :

- créer un interface avec une variété de banques de données pour permettre un accès facile aux demandeurs selon un système de données alphanumériques (pas de graphique) et sans langage SQL ;

- mettre en place une enveloppe globale pour les banques de données du BGS en vue d'une variété d'applications.

De nombreux développements restent à réaliser pour optimiser le système. Les concepteurs sont Peter ROBSON à Edimbourg et Keith ADLAN à Keyworth.

A la demande du DOE, une méthodologie d'accès à l'information concernant les sondages a été mise au point au BGS entre les années 1985 et 1987. Cette réalisation s'est appuyée sur les données de la région de Southampton mémorisées auparavant(1). L'objectif était de répondre aux questions suivantes :

- existence de l'information,
- lien de stockage,
- méthode de stockage,
- accès à l'information.

Pour réaliser l'opération, on a procédé à une extraction en fichiers ASCII de données sondages existant sous ORACLE s'appuyant sur des données graphiques entrées sur le système INTERGRAPH. En pratique, la préoccupation dominante a été le test d'une expérience de démonstration, plus que l'adéquation du montage technologique.

La disposition des données peut en fait se subdiviser en deux volets :

- une information sondages pour une zone donnée,
- un catalogue d'organismes sources de données pour un éventail de thèmes.

D'où deux entrées dans le système, l'entrée géographique et l'entrée catalogue.

Dans l'entrée géographique, on accède aux carroyage de coordonnées du Royaume Uni, une carte à 1/50 000, une région, un nom de lieu, une coordonnée de sondage. Il y a trois échelles géographiques successives emboîtées : 100 km^2, 10 et 1 km^2. En face du canevas cartographique correspondant à chaque niveau, on peut faire apparaître des informations sur les sondages, les zones couvertes par des travaux détaillés, avec les références de rapports.

L'échelle du 1 km^2 est l'échelle graphique la plus fine à laquelle on accède même avec une entrée directe par un sondage. Les logs de sondage ont également été introduits et peuvent être présentés alphanumériquement ou avec une représentation graphique.

Dans l'entrée catalogue, on a croisé l'information thématique (géologie, géotechnique, géophysique, géochimie...) avec les détenteurs de données.

(1) - Source Brian CANNELL.
- Voir également McL. ADLAM K.A et al. (1988) A "demonstrator" for the National Geosciences Data Index. Int. J. Geographical Inform. Systems, vol. 2, n° 2, pp. 161-170. Archivage SGN/SP.

1.2 - CARTOGRAPHIE THÉMATIQUE

En matière de cartographie géologique, le BGS a traditionnellement retenu deux échelles de travail :

- une échelle de lever détaillé à 1/10 000 (ancienne 6 pouces au mille),
- une échelle de synthèse à 1/50 000 (anciennement un pouce au mille = 1/10 260 environ).

Les levers à 1/10 000 sont conservés sous forme de minutes sur calque dont le BGS fournit un tirage à la demande (fig. 2). L'échelle de 6 pouces/mille est celui des anciennes cartes de comté (county sheets).

Alors qu'il y a 3-4 ans, l'existence même du BGS était en cause, celui-ci a obtenu l'accord de NERC pour un programme de révision cartographique étalé sur 15 ans (fig. 3). Le budget de cette opération est agréé uniquement au niveau du principe et représente 45 M livres, dont 3,1 M ont été alloués pour l'exercice 1990-91.

Dans le cadre de ce programme, l'information à 1/10 000 sera obtenu par des nouveaux levers ou utilisation des anciens, puis on synthétisera à 1/50 000. L'approche sera également pluridisciplinaire et prendra en compte des données de géologie, géochimie et géophysique. Par ailleurs, il est prévu d'assurer une actualisation permanente des données selon la technique de "révision continue" qui doit à terme remplacer totalement le programme de révision cartographique. Une faisabilité de cette technique est en cours et les résultats seront connus en mars 1991.

Dans ce programme, l'accent sera mis sur les zones d'importance économique. Environ 30 % du territoire sont classés dans la priorité 1, ce sont les zones urbaines et limitrophes. Certaines zones montagneuses, de moindre importance, sont couvertes selon la technique dite de "lever rapide", partiellement à 1/10 000, synthétisée à 1/25 000, échelle équivalente comme produit de base au 1/10 000 des zones prioritaires.

La production des cartes géologiques à 1/50 000 continuera d'être informatisée soit en mode vecteur (table à digitaliser), soit en mode raster, les deux catégories de données étant reprises sous INTERGRAPH avant de suivre la ligne classique de fabrication. Les besoins sont de l'ordre de 20 cartes/an.

Par ailleurs, le 1/10 000 voit sa vocation d'appui aux problèmes d'aménagement et environnement confirmée. Cette vocation est élargie dans une perspection d'intégration avec d'autres types de données : 1/10 000 topographique raster fournie par l'Ordnance Survey ou spécialement acquis en mode vecteur pour un projet particulier, données de sondages (localisation et logs), zones de travaux spécifiques, localisation des exploitations de mines et carrières, etc...

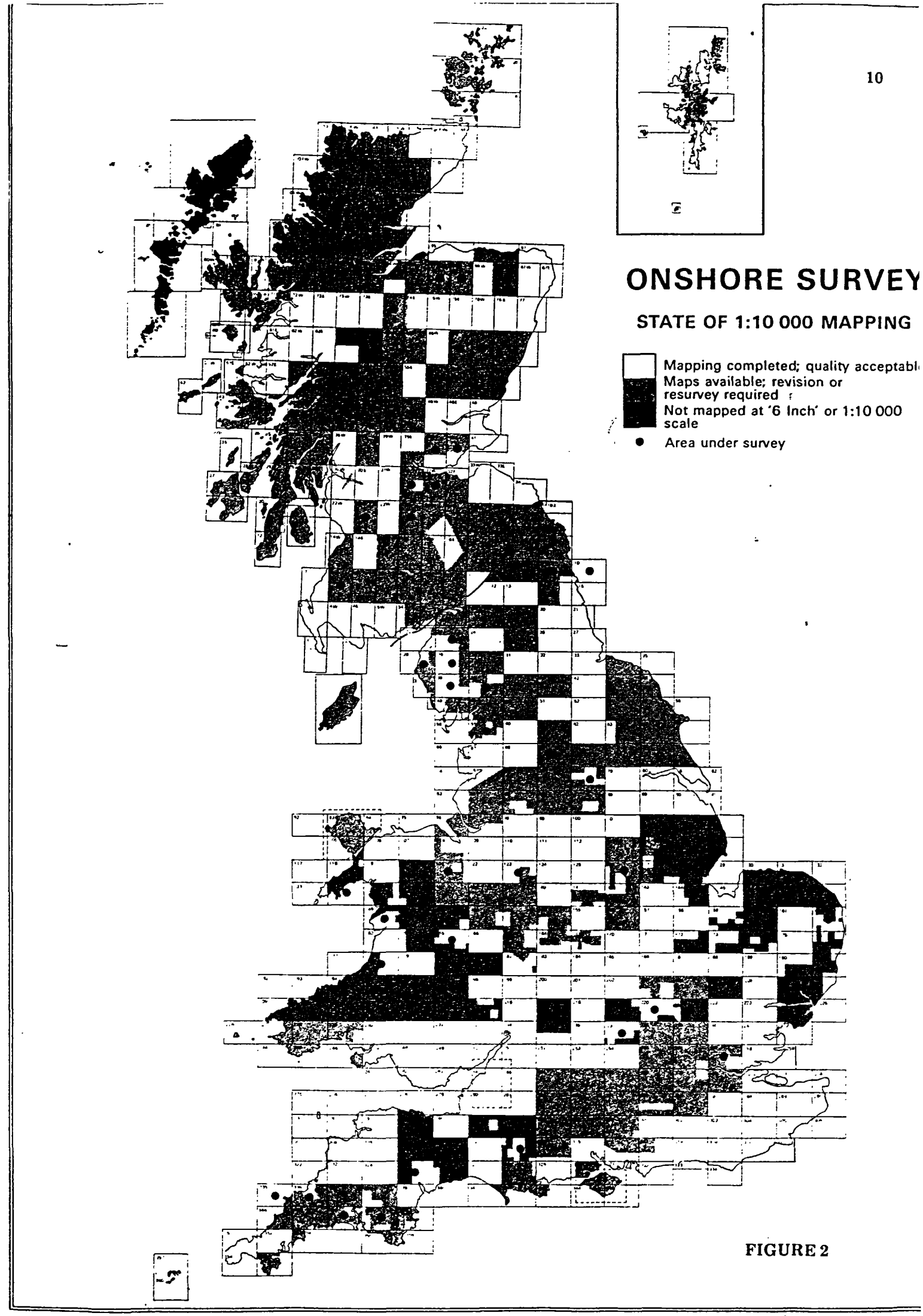
ONSHORE SURVEY
STATE OF 1:10 000 MAPPING
Mapping completed; quality acceptabl
Maps available; revision or resurvey required
Not mapped at '6 Inch' or 1:10 000 scale
Area under survey

FIGURE 2

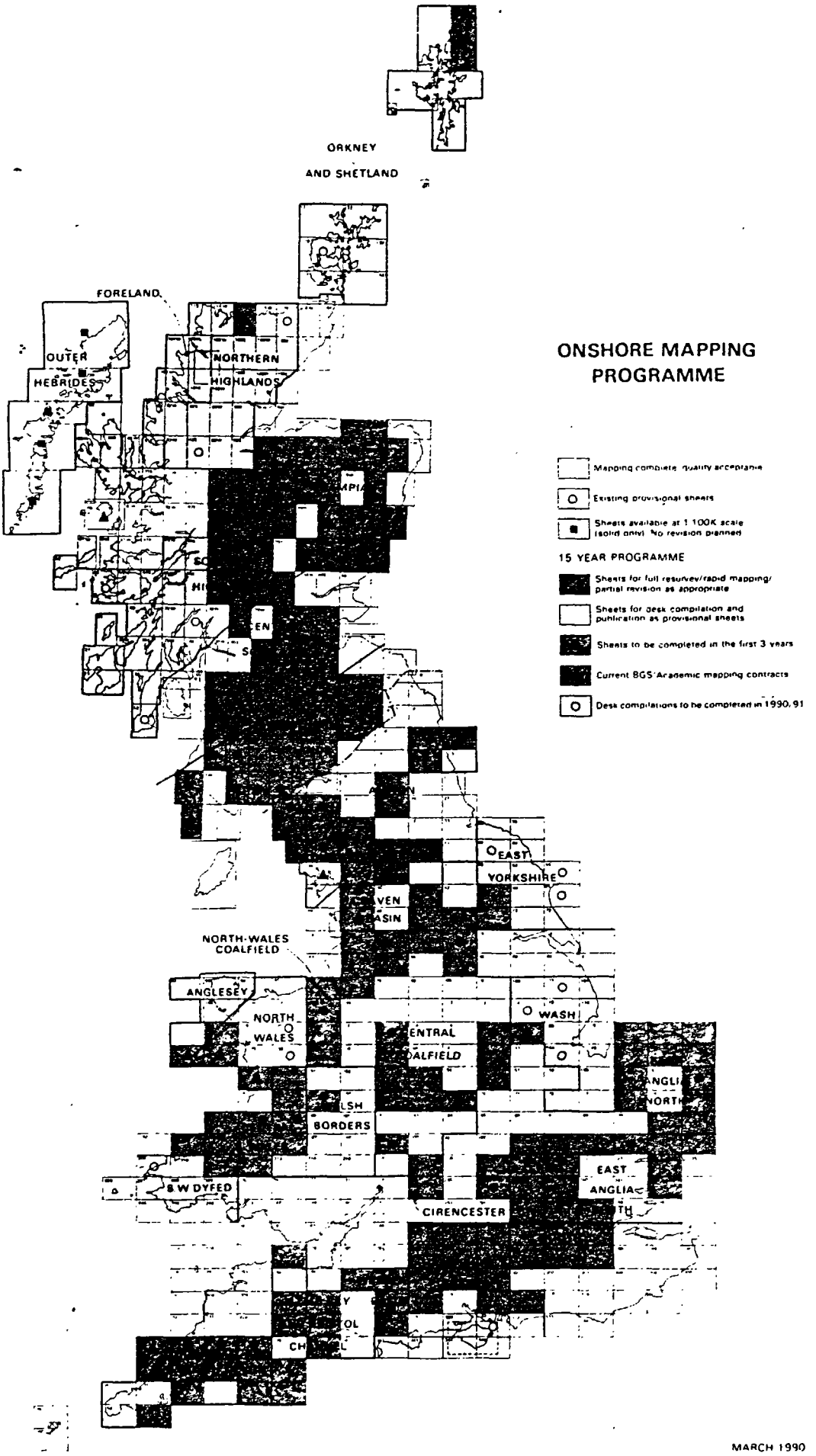
ORKNEY
AND SHETLAND
FORELAND
OUTER
HEBRIDES
NORTHERN
HIGHLANDS
EAST
YORKSHIRE
NORTH-WALES
COALFIELD
ANGLESEY
NORTH
WALES
WASH
BORDERS
EAST
ANGLIA
CIRENCESTER
ONSHORE MAPPING
PROGRAMME
Mapping complete, quality acceptable
Existing provisional sheets
Sheets available at 1:100K scale (solid only). No revision planned
15 YEAR PROGRAMME
Sheets for full resurvey/rapid mapping/ partial revision as appropriate
Sheets for desk compilation and publication as provisional sheets
Sheets to be completed in the first 3 years
Current BGS/Academic mapping contracts
Desk compilations to be completed in 1990, 91
MARCH 1990

FIGURE 3

Actuellement, l'Ordnance Survey(1) peut fournir des films de la topographie à 1/50 000 comme fond pour la carte géologique ou des données raster à 1/10 000 par feuille. Ce balayage raster a été fait à titre provisoire en attendant l'achèvement en 2005 d'une couverture vecteur à cette échelle.

Contrairement à la couverture raster qui est lourde à gérer dans un système intégré car il faut prendre globalement toutes les données d'une carte, le système vectoriel permet de sélectionner les données appropriées. Les données vecteurs informatisées pour les échelles cadastrales (1/2500 à 1/1250) sont disponibles sur les grandes zones d'agglomération, pour lesquelles il y avait un fort besoin exprimé pour les réseaux divers, les limites de propriétés, les communications...(2).

L'Ordnance Survey fournit également les modèles numériques de terrain pour tout le territoire, à l'échelle du 1/50 000. On trouvera en annexe 4, des informations techniques et financières sur les données fournies par l'Ordnance Survey.

La stratégie de cartographie intégrée du BGS conduit à subdiviser les sondages en deux catégories :

- les sondages caractérisés par le référentiel général. Ceci vaut pour la banque complète (dans les limites de son informatisation actuelle),
- les sondages sélectionnés pour leur qualité pour être pris en compte dans le produit à 1/10 000, des coupes géologiques ou des corrélations.

La stratégie du BGS consiste maintenant à fournir un produit à 1/10 000 rénové comportant une informatisation des contours géologiques à cette échelle et un interfaçage avec des données alphanumériques correspondant à des sondages, des exploitations, des secteurs travaillés en détail, etc. Des expériences sont également en cours en matière d'informatisation dès le stade des levers avec une gestion interactive sur écran avec le logiciel AUTOCAD.

Les résultats d'une enquête du BGS sur les besoins des utilisateurs sont donnés en annexe 5.

Pour appuyer cette stratégie, le BGS a en cours plusieurs essais :

- projet de Wrexham (Pays de Galles) financé par le DOE (350 000 livres). L'opération porte sur 9 cartes à 1/10 000 (250 km^2) dont il a fallu relever 10 %. La totalité de l'information cartographique est digitalisée, de même que l'information sur les logs de sondage. On dispose également des modèles numériques de terrain. Conformément à la demande du DOE, on a réalisé les documents suivants :

  • épaisseur du quaternaire,
  • toit du Préquaternaire
  • distribution des sondages,
  • repérage des exploitations anciennes,
  • caractéristiques géotechniques des terrains.

  Ce projet doit être achevé pour fin 1990.

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(1) Ordnance Survey, Sales Department, Romsey Road, Maybush Southhampton. 509 4 DH.

(2) Le territoire est couvert par 3670 feuilles à 1/10 000, 54.400 à 1/2500 et 162 600 à 1/25 000.

- projet de Birmingham, analogue au précédent et soutenu par le DOE également. Achèvement prévu début 1992 ;

- discussions en cours avec l'Institut d'Ecologie Terrestre (NERC) pour la prise en compte de leur données ;

- discussions en cours avec le Soil Survey (P. BULLOCK) de Silsoe pour une approche intégrée géologie-pédologie(1).

Le DOE soutient l'optique de la gestion de données intégrées multisources y compris socio-économiques. En mai 1990, le DOE a soutenu une conférence internationale sur ce thème. C'est également la position du Conseil de la Recherche Economique et Sociale (Economic and Social Research Council) qui a soutenu plusieurs essais pilotes conduits par des départements universitaires de géographie. Dans une première phase, on ne s'est occupé que de données socio-économiques. Dans une deuxième phase, l'Université de Leicester a proposé une intégration avec les données géologiques et le BGS soutient cette action(2).

Ces orientations ne sont pas totalement en harmonie avec les besoins exprimés par les "planificateurs" dont les demandes portent plutôt sur les données brutes(3). Il y aura certainement un équilibre à trouver.

Pour l'informatisation du 1/10 000 et d'une façon générale la cartographie thématique, des essais satisfaisants ont été faits avec deux équipements différents : Läser Scan (Läser Scan Holdings) soutenu par un groupe de travail de NERC et ARC-INFO.

Les autres logiciels utilisés sont :

- ISM (Dynamic Graphics) : modélisation des surfaces en 2 D $\frac{1}{2}$;
- GRAPH LOG et WELL LOG pour les logs de sondage et les corrélations entre sondages.

On notera qu'alors que la cartographie géologique relève du service public fourni par le BGS, celui-ci n'envisage pas pour l'instant de travailler autrement que sur contrats pour la cartographie thématique.

(1) Cf. rapport DS n° 53 du 20.02 1989, pp. 91-105.

(2) Drk. Alan J. STRACHAN. Midlands Regional Research Laboratory. C/O Dept. of Geology Leicester Univ. Leicester LE1 7RH. Tel. : 0533 523 849 ; Fax : 05333 52 2200.

(3) L'expérience de Fife-Glenrothes dans la zone de Glasgow-Edimbourg a été un peu unique en son genre. Cf. rapport DS n° 53 du 20.02.1989, pp. 28-35.

Une réalisation récente du BGS en matière de cartographie thématique nous a été remise(1). Il s'agit d'un travail réalisé entre 1986 et 1989 sur financement du BGS et du DOE, à des fins de planification et développement. La zone étudiée fait partie de la zone charbonnière de Northumberland et se caractérise par de nombreuses zones de déblais et de travaux miniers abandonnés. Une dizaine de cartes à 1/25000 accompagnent le texte explicatif :

- géologie du socle,
- Quaternaire,
- isohypses du socle,
- isopaques du Quaternaire,
- exploitation à faible profondeur,
- secteurs de déblais et perturbés,
- sites de sondages et de puits,
- géologie de l'ingénieur,
- ressources minérales et aquifères ; extraction (sauf charbon),
- facteurs géologiques à prendre en compte dans l'occupation de l'espace.

1.3 - CONCLUSIONS

Il y a assurément matière à expériences comparatives entre le BGS et le BGS dans le domaine de la cartographie thématique sur les thèmes suivants :

1 - méthodologie de lever à 1/10 000 très orientée vers les ingénieurs, développeurs et pour laquelle le BGS a une expérience centenaire ;

2 - gestion intégrée de données de type cartographique, de sondage et documentaires ;

3 - gestion intégrée de données géologiques et socio-économiques.

Sur le point 1, il convient dans un premier temps qu'un spécialiste du BRGM se rende au BGS pour se familiariser avec la méthode et les problèmes posés.

Sur le point 2, il faut attendre que les expériences pilotes du BGS soient plus avancées et rendez-vous est pris pour mi-1991. Cette date pourrait être mise à profit pour étudier les résultats de l'expérience pilote conduite sur le point 3 à l'Université de Leicester avec l'appui du BGS.

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(1) JACKSON I., LAWRENCE D.J.D. (1990) - Geology and land-use planning: Morpeth-Bedlington-Ashington. BGS Tech. Rep. WA/90/14. Onshore Geology Series.
Archivage SGN/SP.

2 - HYDROGÉOLOGIE ET GÉOCHIMIE

2.1 - HYDROGÉOLOGIE

En matière d'hydrogéologie, le contact est le Dr. S.S.D. FOSTER. Les indications qui suivent proviennent de J. MATHER, responsable du département de géochimie et hydrogéologie mais qui doit quitter le BGS en septembre 1990 pour le Royal Holloway Bedford New College.

A l'intérieur du Royaume Uni, le grand changement récent est la privatisation des Water Authorities qui se sont subdivisées en deux: une composante privée, les compagnies PLC distributrices d'eau sur le plan commercial et la National Rivers Authority (NRA) qui a une fonction administrative et assure également la coordination de la recherche.

Cette restructuration entraîne que l'activité de recherche dans le domaine de l'eau et de la pollution par les déchets relève maintenant de NRA. Le DOE garde la haute main sur les études concernant les déchets eux mêmes (recyclage, incinération...) ainsi que la composante gaz.

Afin d'évaluer s'il y a des actions communes possibles en matière de recherche en hydrogéologie en Grande Bretagne, c'est avec NRA qu'il convient de prendre contact, au-delà des discussions qui peuvent avoir lieu avec S. FOSTER. Les personnes à contacter sont :

- J. BOWMAN, chief executive,
- Dr. Jan PENTREATH, responsable scientifique,
- Merwyn BRAMLEY : R&D, dépend de Jan PENTREATH,
- Mike EGGBORO : coordination de la recherche en eau souterraine, NW Office Warrington.

J. MATHER suggère de commencer par Jan PENTREATH.

Le Water Research Centre (WRC) effectue beaucoup de travaux pour le compte des compagnies PLC, moins semble-t-il pour NRA.

Malgré la subdivision, NRA est encore très régionalisée. Le département d'hydrogéologie du BGS se préoccupe de ressources en eau et de pollutions agricoles (nitrate, pesticides) en liaison avec le WRC. Les rapports NRA-BGS ne sont pas encore établis sur un rythme de croisière, mais il n'est pas certain que l'activité de recherche en hydrogéologie sera mieux soutenue qu'auparavant et que la NRA ne renforcera pas sa propre activité.

Le problème de la masse de données de sondages existant dans les anciennes Water Authorities et non archivée au BGS reste pendant (cf. Dick MONKHOUSE au BGS).

La cartographie de vulnérabilité se poursuit au BGS. Après la publication des cartes de Severn Trent(1), il y a eu un travail similaire fait sur l'Anglia, non publié pour des raisons politiques. Le travail est en cours sur la zone de Southern Water.

A l'étranger, l'activité du BGS se poursuit dans la ligne qui existait en 1988(2), et selon J. MATHER, le BGS est favorable à des actions communes BGS-BRGM de recherche à l'étranger en s'appuyant sur les financements de R&D de l'ODA. Ceci vaut pour les travaux sur le milieu fissuré. Le projet envisagé par J.J. COLLIN et Mike EDMONDS(3) pour le prochain appel d'offres STD (cf. supra) rentrerait ainsi dans cette logique.

L'activité de modélisation en matière d'hydrogéologie des aquifères reste modeste. La stratégie a été principalement d'acquisition de modèles USGS, sans développements spécifiques propres. Pas de développements particuliers à noter pour l'étude de l'interface eau douce - eau salée.

Dans le milieu universitaire, la principale équipe de R&D est celle de J. LLOYD à l'Université de Birmingham. C'est la seule chaire d'hydrogéologie en Grande Bretagne. Deux thèses de Ph D ont été récemment soutenues sur le thème des polluants organiques.

Ailleurs, on trouve l'hydrogéologie intégrée à l'ingénierie civile ou aux sciences de la Terre. C'est le cas de l'Université de Newcastle (Ende O' CONNELL, modélisation hydrogéologique dans le cadre du département d'ingénierie civile), de celle de Bath (radioactivité des eaux) ou de celle de Reading (J. ANDREWS, département de sédimentologie).

2.2 - FLUID PROCESSES (FP)

Cette équipe est maintenant dirigée par A. BATH, après le départ de N.A. CHAPMAN (fig. 4). J'avais déjà eu l'occasion de le rencontrer en 1988(4) et, au BRGM, il connaît P. PEAUDECERF, P. MASURE (rencontré du temps où celui-ci était à Bruxelles) et R. FABRIOL (rencontré dans le cadre de CHEMVAL).

FP dispose d'équipements pour les expérimentations de laboratoire (essais batch, colonnes, cellules de diffusion) et les analyses organiques (GC, détecteur).

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(1) DS n° 53 du 20.02.1989, p. 25.

(2) DS n° 53 du 20.02.1989, pp. 50-51.

(3) Parle très bien français.

(4) DS n° 53 du 20.02.1989, p. 49-50 et 65-69.

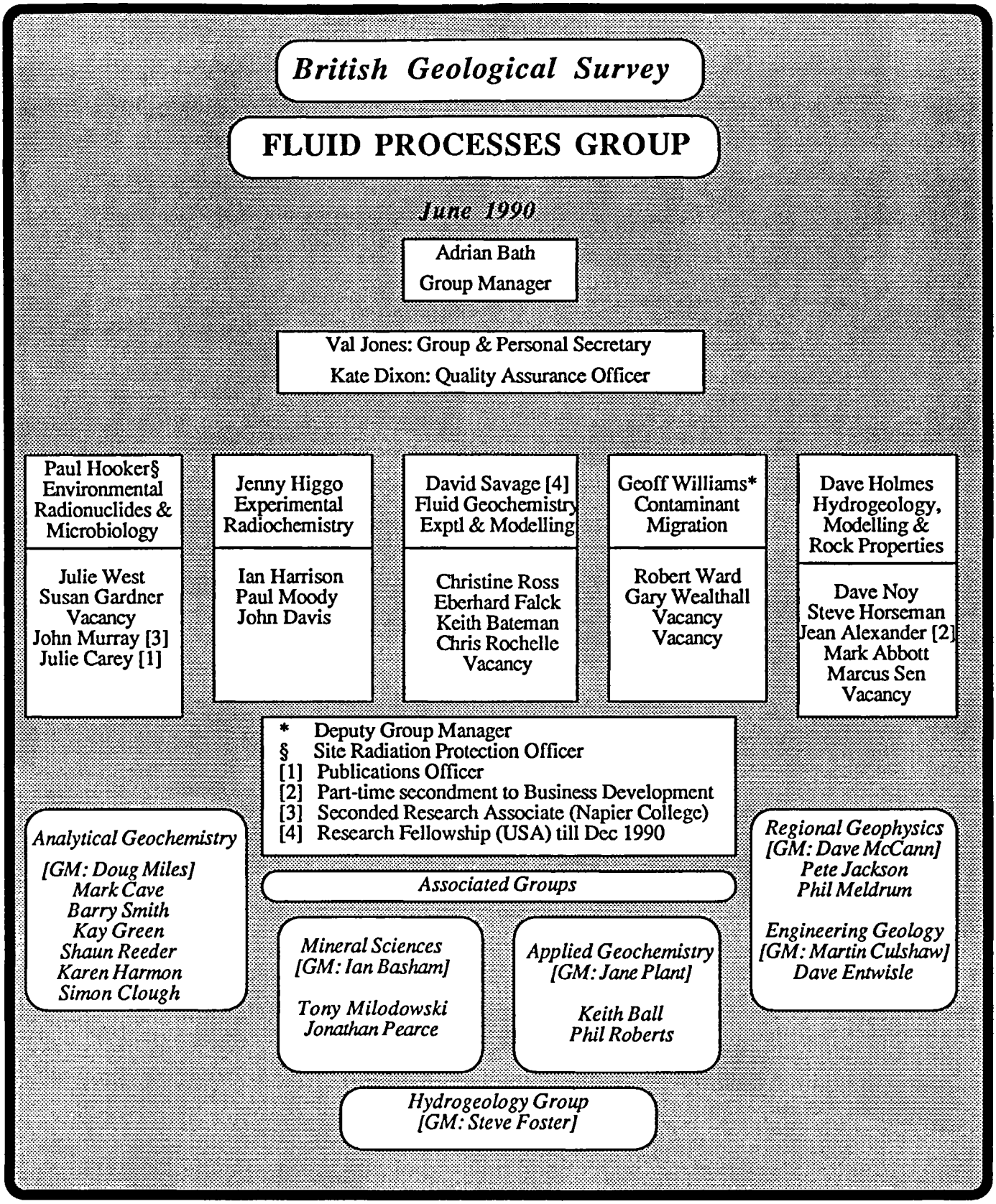

FIGURE 4

ORGANIGRAMME DU FLUID PROCESSES GROUP DU BGS

2.2.1 - Activités pour NIREX

50 % de l'activité de FP est réalisée pour NIREX, équivalent de l'ANDRA en Grande Bretagne, dans le cadre d'un contrat de gré à gré. Ce contrat comprend deux parties :

- une assistance d'expert (70 %) sur les deux sites de stockage en cours d'étude (Sellafield et Dounreay) qui correspondent à des sites de centrales nucléaires existantes(1). Le deuxième correspond au site retenu de surgénérateur européen retenu par la CCE, mais non soutenu par le Gouvernement britannique. Comme beaucoup d'emplois régionaux relèvent de ces deux centrales, la population n'a pas marqué son hostilité au choix des deux sites. Les travaux sont conduits par des sociétés privées sous la coordination de NIREX, aidé du BGS. Un sondage a déjà été réalisé à Sellafield, deux autres sont prévus. Deux sondages sont également programmés pour le site de Dounreay. Le calendrier est très serré car les résultats doivent être soumis au public d'ici 1991 ;

- des travaux de R&D (30 %) effectués à la demande de NIREX depuis un an environ et qui comportent principalement deux volets :

    - géochimie des déplacements des radionuclides dans une fracture ;
    - étude expérimentale sur l'effet de l'eau alcaline sur les roches silicatées.

Cette partie recherche est gérée par Harwell qui prend sa dîme au passage.

Les autres travaux prévus sur les deux sites seront soumis à la procédure d'appel d'offres pour lesquels le BGS sera en concurrence avec d'autres postulants. Le BGS a ainsi soumissionné pour la surveillance géochimique des sites et les traçages isotopiques, pour une enveloppe globale de 700.000 livres.

Pour ses études, FP a accès au code en éléments finis NAMMU (Numerical Algorithms for Mass Migration) développé par Harwell, moyennant un forfait d'utilisation de 40 000 livres. Il s'agit d'un code 2-3 D qui couvre à l'échelle régionale : hydrodynamique, température, densité, pour une seule phase chimique. C'est un code très compliqué, en développement depuis une quinzaine d'années par segments successifs. Le contact à Harwell est John PORTER et, à FP, Dave Noy et Marcus SEN.

2.2.2 - Autres activités

Elles concernent d'une façon générale les déchets qu'ils soient radioactifs ou non et les études de traçage, modélisation, détection qui sont associées.

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(1) Un descriptif historique de l'évolution de la politique de NIREX est donné dans le rapport DS n° 53 du 20.02.1989, p. 49-50.

a) Déchets radioactifs

En ce qui concerne les **déchets radioactifs**, les actions non NIREX sont principalement soutenues par le DOE qui fournit les entreparties nécessaires aux actions CCE, NIREX en soutenant d'autres. Le tableau 1 présente l'ensemble des projets proposés à la CCE au titre du programme 1990-1994.

Un autre projet, en cours d'achèvement, concerne les **analogues naturels.** Il s'agit d'un projet CCE soutenu par le DOE et pour lequel FP a collaboré avec MM. LEDOUX et JAVIET de l'ENSMP. Deux filons d'uranium ont été étudiés en Ecosse. Les résultats ont été partiellement concluants (cf. le propre projet BRGM sur ce thème).

Le domaine des traçages fait l'objet de nombreux travaux de FP avec un effort de modélisation pour l'interprétation (cf. D. NOY et M. SEN). Ils semblent ignorer l'existence du modèle CATTI.

Dans le cadre du nouvel appel d'offres MIRAGE III de la CCE, une proposition a été faite avec Delft Geotechnics, le RIVM, l'Université de Newcastle, Harwell et l'ENSMP (M. GOBLEY). Elle a pour titre "application of models to the field study of tracer migration in a heterogeneous system".

En ce qui concerne l'étude des **argiles** comme milieu de stockage de déchets radioactifs, beaucoup de travaux ont été réalisés pour NIREX, du temps des programmes antérieurs à l'étude des deux sites de Sellafield et Dounreay. Ce programme était également soutenu par le DOE. Il se poursuit à petit rythme sur le seul budget propre du BGS. On notera en particulier l'étude des flux dans les systèmes hétérogènes (sables et argiles) poursuivie par G. WILLIAMS et des travaux sur la chimie des eaux intersticielles et le comportement des failles en milieu argileux.

Durant toutes ces années un courant régulier d'échanges a été maintenue avec la NAGRA. Un séminaire de deux jours vient d'avoir lieu à Harwell, qui a clairement montré, la différence entre l'approche très modélisatrice d'Harwell, et l'optique "études sur site" préconisée par la NAGRA.

b) Dispositif RESCAN

L'étude de l'hétérogénéité des aquifères a donné lieu à la mise au point du dispositif géophysique RESCAN. La méthode consiste à mesurer et détecter le cheminement des fluides dans l'aquifère à l'aide d'un traceur injecté (NaCl) apportant un contraste de résistivité suffisant. Le dispositif fonctionne d'une façon très simple en surface et en sondages (3D) avec un central d'acquisition de données. Les essais de laboratoire et deux essais *in situ*, en Grande Bretagne et au Canada (avec de l'ethylène) en collaboration avec l'Université de Waterloo, ont été positifs. La technologie radar n'a pas par contre apporté des résultats concluants.

Un descriptif du système RESCAN est donné en annexe 6. L'objectif actuel est d'aller vers une tomographie 3D permettant une visualisation du déplacement dans le temps de l'enveloppe de produit traçeur. Il est prévu d'appliquer la technologie RESCAN dans le projet d'étude des panaches de pollution des décharges soumis à STEP et qui associe le BGS, le BRGM (A. BOURG) et l'Université technique du Danemark.

TABLEAU 1

25/6/90

Summary of Proposals from FPRG/BGS to CEC on the Radioactive Waste Management R&D Programme for 1990-94

(Approved projects are likely to start around 12/90 at the earliest)
(Values given are the BGS costs at 100%; 50% contribution expected from e.g. Nirex, UKDoE, Enresa)

1. Geochemical validation of solute residence times: Review and comparison for various geological environments
   BGS/FPRG/UKNirex (A Bath) + GSF Germany
   3 yrs
   £90990 (123460 Ecu)

2. Hydrogeological testing and characterisation of El Berrocal site (Spain) prior to migration experiments for radionuclides
   Enresa Spain + BGS/FPRG (D Holmes & A Bath)
   3 yrs
   £229965 (312034 Ecu)

3. The effect of microbial activity on the near and far fields of a deep repository
   BGS/FPRG/UKNirex (J West) + CEA France
   2 yrs
   £214928 (290153 Ecu) [Total proposal value 545077 Ecu)

4. Metal speciation in uranium rich waters
   BGS/FPRG/UKNirex (J Higgo)
   2 yrs
   £315400 (425800 Ecu)

5. In situ migration studies in a glacial sand aquifer
   BGS/FPRG/UKDoE (J Higgo)+ CEA France + GSF Germany + Uni Loughborough UK + LSLA France
   3 yrs
   £481000 (649350 Ecu) [Total proposal value 1228914 Ecu]

6. Migration of gases in geological environments (MEGAS)
   SCK-CEN Belgium + BGS/FPRG (S Horseman)
   3 yrs
   £162722 (220000 Ecu)

7. Modelling studies of the Oklo natural reactor: a natural analogue for radionuclides
   CEA France / FPRG (D Noy)

   £64390 (87368 Ecu)

8. Consistent approach to migration mechanisms for engineered repositories (CAMMER)
   WS Atkins UK + BGS/FPRG (S Horseman) (also several other EC participants)
   3 yrs
   £110947 (150000 Ecu)

9. Natural system studies of radionuclide migration
   BGS/FPRG/UKDoE (P Hooker) + CEA France + SURRC UK + EMP France
   3 yrs
   £335337

10. Application of models to the field study of tracer migration in a heterogeneous system
    BGS/FPRG (G Williams) + Delft Netherlands + RIVM Netherlands + Uni Newcastle UK + AEA Harwell UK + EMP France
    4 yrs
    £1063054 (1442406 Ecu) [Total proposal 2374112 Ecu]

c) Pollution à partir des sites de déchets

Les travaux de recherche sur les processus de transfert des polluants à partir des sites de déchets constitue une constante d'étude de l'équipe FP(1). D'une façon générale, SP intervient à la demande du DOE sur des sites posant problème. Il n'y a pas d'intervention systématique du BGS de type inventaire ou étude d'impact avant l'autorisation qui incombe aux autorités locales.

Le site de **Villa Farms** au nord de Coventry, a fait l'objet d'un suivi méthodologique depuis une quinzaine d'années, sur financement du DOE, en particulier depuis son abandon en 1981 après 30 ans d'apports de déchets industriels. On a identifié un éventail très large de polluants métalliques et organiques dont on a suivi l'évolution (dégradation) et le déplacement, en s'appuyant sur plusieurs profils de piézomètres de contrôle ainsi que des essais en laboratoire. Ces travaux ont permis en particulier d'établir une zonation des panaches par produit à travers la transition zone réduite - zone oxydante. Faute du maintien de financement du DOE, les travaux sur Villa Farms sont maintenant arrêtés.

Un autre site étudié, cette fois dans l'optique émanation de gaz, est celui de **Loscoe** (Derbyshire). Le 24.03.1986, une explosion de gaz provenant du site a entièrement détruit un bungalow. L'étude réalisée par FP, a porté sur la distribution du gaz émanant du site et la caractérisation géologique.

Depuis plusieurs années, les émanations de gaz avaient eu un impact sur la végétation du site, dont on n'avait pas alors tenu compte. Une publication de synthèse sur le travail réalisé est prévue dans le Quaterly Journal of Engineering Geology.

Parmi les autres thèmes d'intérêt pour SP, on peut citer :

- la spéciation des radionuclides. Il s'agit de programmes soutenus par la CCE et le DOE et qui concernent plus particulièrement les effets des acides humiques et fulviques sur la complexation des radionuclides. Dans le cadre de MIRAGE II, de nombreux travaux ont été réalisés sur le site de Drigg près de Sellafield sur les problèmes de déchets de courte vie. Ces travaux ont été publiés. Ils ont comporté un volet laboratoire et une rubrique *in situ*. Une orientation récente concerne la caractérisation des acides humiques de différents sites ;

- le transport par colloïdes. Ce thème a été amorçé il y a moins d'un an et il est soutenu par le DOE ;

- la caractérisation du méthane naturel et de celui issu des décharges, en s'appuyant sur des études isotopiques. K. BALL poursuit par ailleurs ses travaux sur le risque lié au radon (inventaire, caractérisation de différentes roches...) dans le cadre de programmes CCE.

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(1) Voir en particulier les travaux de G.M. WILLIAMS :
- Integrated studies into groundwater pollution by hazardous waste. In : Land disposal of Hazardous Waste: Engineering and Environmental Issues. Ed. J.R. GRONOW et al. Ellis Horwood Ltd. Chap. 2.1, pp. 37-48.
- The migration of leachate and gas from landfills.

2.2.3 - Publications

Une liste complète des publications 1980-89 de FP est donné dans l'annexe 7. Une liste plus spécifique des publications concernant les déchets 1974-1990 est donné dans l'annexe 8.

3 - GÉOCHIMIE APPLIQUÉE (AG)

Ce service est dirigé par Mme J. PLANT et il comprend environ 35 personnes. Les travaux sont conduits au Royaume Uni et à l'étranger.

J. PLANT est bien connue de DAM/DEX. Un projet commun BRGM-BGS a été proposé à la CCE dans le cadre du dernier appel d'offres Matières Premières Minérales et agréé. Il s'agit du projet MIDAS (multidatasets analysis for the development of metallogenic and economic models and exploration criteria for gold deposits in Western Europe)(1) pour lequel on utilisera largement SYNERGIS dans les traitements combinatoires de données.

L'équipe d'AG intervient dans trois domaines principaux :

1 - prospection des substances métalliques,
2 - géochimie de l'environnement,
3 - soutien à la cartographie géologique.

Les échantillons de la prospection (et les indications et résultats d'analyse associés) sont stockés dans la banque centrale du BGS et gérés sous ORACLE (cf. supra 1).

Le thème 1 est soutenu principalement par le Department of Trade and Industry, sauf pour les travaux à l'étranger en général commandités par l'Overseas Development Agency (ODA). Le DOE soutient le volet 2.

Jusqu'ici, l'inventaire Royaume Uni, qui s'appuie sur un échantillonnage des sédiments de ruisseaux, des concentrés lourds et des eaux (pas de biogéochimie), s'effectue de façon systématique du nord au sud du pays et se traduit notamment par la publication de luxueux atlas. Le 6ème volume de ces atlas (Great Glen) a été publié fin 1987 et il est question de ne pas poursuivre la mise à disposition des résultats sous cette forme mais de la présenter numérisée en bandes, disquettes, listings, voire cartes.

Cet inventaire stratégique se poursuit sur zones sélectionnées par des travaux plus détaillés dits de "mineral reconnaissance"(2). A l'étranger, le BGS travaille également selon ces deux approches.

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(1) Chef de projet BGS. 100 000 écus (689 KF) pour le BRGM sur 30 mois. Contrepartie 50 % sur RM13B. Sept partenaires en tout, dont RTZ.

(2) Cf. : The Mineral Reconnaissance Programme 1990.
Technical Report WF/90/6. Archivage SGN/SP.

Depuis le début des années 1980, la stratégie de l'équipe de géochimie appliquée en matière de recherche minière est sous-tendue par quelques orientations fortes(1) :

- la géochimie de bassin (pétrole et gîtes minéraux) avec le concept de bassins fertiles,
- la notion de réservoir crustal, où se génèrent les préconcentrations qui donneront plus tard des gisements ;
- l'approche pluriméthodes : géochimie, géophysique, géologie(2).

Plus récemment, le choix a été fait de prendre un certain recul par rapport à la conjoncture, en assurant une continuité dans l'étude de certaines substances.

Dans le domaine de l'environnement, c'est également l'optique inventaire qui prévaut, du moins au niveau de l'équipe AG, puisque nous avons vu beaucoup d'études de sites à problème réalisées par FP. De nombreuses études de sites sont confiées à des bureaux privés.

Les traitements combinatoires d'images géochimiques ou géophysiques sont traitées sous ERDAS en mode raster, en s'appuyant sur des logiciels développés par le BGS.

L'impression des cartes dérivant de ces données est sous traitée à l'extérieur du BGS pour un coût de 3000-5000 livres par feuille. Il s'agit de cartes scannérisées, en mode vecteur.

J. PLANT soutient fortement le principe de collaborations avec le BRGM et d'actions CCE communes(3). En dehors du projet commun déjà évoqué et pour lequel le BRGM met l'accent sur les linéaments et le BGS les réservoirs crustaux, une collaboration spécifique sur la morphologie des grains d'or est envisagée. Ce projet correspondrait à une poursuite des travaux de P. FREYSSINET sur ce thème. Le correspondant BGS est le Dr. R. LEAKE.

Un autre thème d'étude potentiel est celui des platinoïdes, mais jusqu'ici le BGS a surtout étudié le milieu tempéré. Le correspondant BGS est le Dr. G. GUNN qui a essentiellement travaillé sur la zone des Shetlands (géochimie, minéralogie).

J. PLANT soutient également le principe d'études conjointes à l'étranger en particulier en contexte tropical.

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(1) PLANT J.A. et al. (1988) - Developments in regional geochemistry for mineral exploration. Trans I.M.M., B., 116-140.

(2) PLANT J.A. & JONES D.G ed (1989) - Metallogenic modes and exploration criteria for buried carbonate hosted ore deposits. A multidisciplinary study in Eastern England. BGS-IMM.
Ce volume concerne principalement la géophysique ; un autre volume est prévu pour la géochimie. Voir également Mineral deposits within the European Community, Springer Verlag, pp. 321-352.

(3) Avec une variété de partenaires. Une action CCE vient d'être terminé sur le thème des granites potentiels pour U et Sn et s'appuyant sur trois terrains de jeu : granite de la Manche (B. POTY, CREGU), granite de Fichtelgebirge (Univ. Münich), granite de Cairngorn en Ecosse (BGS).

4 - GROUPE DE RECHERCHE SUR LES SCIENCES MINÉRALES

Ce groupe de recherche est dirigé par I.R. BASHAM, dont dépend David MORGAN notre interlocuteur. Le groupe comprend 28 personnes réparties sur les activités suivantes :

- soutien au programme de cartographie et d'études géologiques au Royaume Uni (pétrologie, minéralogie...) : 4-5 personnes. Travail assez académique ;
- programme de prospection minière (mineral reconnaissance) ; études de gîtes minéraux et de minerais : 6 spécialistes (minéralogie) ;
- études de sites de déchets radioactifs ; études de roches argileuses (diffractométrie X...) : 5 spécialistes ;
- coopération à l'étranger ; surtout études des minéraux industriels, dont caractérisation et enrichissement : 6-7 personnes ;
- travaux contractuels du type géologie de l'ingénieur : 1-2 personnes ;
- personnel technique d'appui (lames minces, collections...) : 6 personnes.

Les équipements de minéralogie fine (diffracto X, MSE, MEB...) sont localisés dans cette équipe qui dispose également d'équipements pour les études d'orientation en matière de traitement des minerais et minéraux. Ce type de travaux ne dépasse pas une certaine limite pour ne pas interférer avec Warren Springs. En particulier, aucun travail de pilotage n'est réalisé au BGS.

A noter également la parution d'un annuaire tous les deux ans. Nous avons rapporté celui de 1988. Celui de 1990 est en cours d'élaboration. L'expérience du groupe en minéraux industriels est forte avec en particulier les travaux à l'étranger (Extrême Orient, Kenya, Costa Rica).

A une question sur le coût d'accès aux équipements, D. MORGAN nous a fourni les éléments suivants :

- coûts de personnel/jour en livres :

  - scientifique principal : 340,
  - scientifique senor : 250,
  - scientifique : 160-200.

- travail au MEB (coût pour l'extérieur) :

  - travail courant : personnel + photos + 20 livres/h,
  - travail fin, microanalyse : personnel + photos + 40 livres/h,

- travail à la MSE (coût pour l'extérieur) :

  - travail courant : personnel + 30 livres/h,
  - travail fin (analyse WDS fine, recherche de phases rares, microchimie) : personnel + 70 livres/h.

- préparation :

  • pour MEB : 5 livres,
  • pour MSE : 15-20 livres.

Au niveau interne, l'accès aux instruments se fait en payant le personnel et ± les coûts de photos, pas le coût complémentaire à l'heure. Les amortissements sont intégrés aux FG du BGS.

Dans l'optique de propositions communes au prochain appel d'offres CCE en liaison avec des exploitants de minéraux industriels du Royaume Uni, D. MORGAN réfléchit aux thèmes suivants qui lui ont été proposés :

- application de techniques minéralogiques sophistiquées et études gîtologiques ;
- délaminage ;
- optimisation de l'exploitation à l'aide de techniques informatiques ;
- optimisation de la simulation des procédés et de la gestion des usines ;
- optimisation des propriétés minérales pour des applications spécifiques. Synthèses minérales.

5 - GÉOLOGIE ET GÉOPHYSIQUE MARINES

En l'absence de Chris Evans, responsable des Marine Surveys (South), la discussion a eu lieu avec Robin WINGFIELD.

La couverture offshore à 1/250 000 est presque terminée. Cette couverture comprend géologie du bed rock, géologie du Quaternaire, sédiments du fond marin, gravimétrie, aéromagnétisme. En outre, une large part du territoire concerné est couverte de profils sismiques. Les données d'aéromagnétisme et de sismique sont informatisées, de même qu'une bonne partie des échantillonnages géologiques.

Une synthèse à 1/1 000 000 est en cours d'élaboration. Le magnétisme est déjà disponible, les autres volets devraient suivre et, sur ce point, une bonne liaison avec le 1/1 000 000 en cours d'élaboration par le BRGM est favorablement reçue.

Le BGS a deux autres projets offshore en tête :

- la sortie d'une carte de l'Atlantique du NW à petite échelle, en utilisant les travaux des sociétés ;
- une étude du Quaternaire à travers un secteur Grande-Bretagne-France couvre la Mer celtique. Cette zone correspond à la limite de l'avançée des glaciations quaternaires et présente d'intéressants problèmes de variations de faciès. Intérêt académique et pour la géoprospective. La CCE a financé un programme sur le Quaternaire de la mer du Nord en 1989 qui présente un intérêt géotechnique notamment R. WINGFIELD envisage un projet comparable pour la mer celtique.

Avec l'achèvement des couvertures, le secteur des "marine surveys" du BGS est en phase de reconversion. Les plans font état d'une réduction très forte du personnel couvert par les financements du Dept of Energy (70 hommes/an en 1990, 35 à partir de mars 1991 et 5 ou moins en 1992), que l'on espère dans une certaine mesure compenser par la cartographie du littoral à des échelles variant du 1/50 000 au 1/10 000 et pour des objectifs de géologie appliquée : érosion côtière, risques d'inondation. Cette cartographie comporterait bathymétrie, sédiments de surface, géologie du soubassement, profils...

D'ores et déjà certains travaux ont été réalisées associant la partie terrestre et le littoral : baie à l'E de Nottingham (feuille Kings Lynn à 1/50 000), Bristol Channel... L'objectif n'est d'ailleurs pas forcément de fournir des cartes. Après le refus des Ministères de financer un programme de 20 ans de cartographie côtière, les opérations se feront au cas par cas et sur contrats spécifiques (Water Authorities par exemple).

Pour ce qui concerne les projets de cartographie du plateau continental du BRGM, il n'y a aucun problème d'accès aux données du BGS. R. WINGFIELD doit en particulier vérifier ce qui est disponible au point de vue géophysique entre le Cotentin et l'extrémité ouest de la Bretagne.

6 - BIOSTRATIGRAPHIE

L'entretien avec B. OWENS a été sollicité afin d'évaluer les thèmes de collaboration possibles entre BRGM et BGS.

L'équipe de biostratigraphie du BGS comprend 30 personnes, dont 17 biostratigraphes (10 micropaléontologistes, dont 8 palynologues), 7 macropaléontologistes et 13 sismostratigraphes.

Sur le thème du Quaternaire et des glaciations, aucune réponse précise n'a été obtenue :

- mouvements isostatiques : voir Martin CULSHAW responsable de la section de géologie de l'ingénieur. Le BGS ne semble pas toutefois avoir une activité dans ce domaine ;
- coupes types du Quaternaire permettant d'avoir accès au démarrage des glaciations ainsi qu'à la dernière (demande BRGM) : des coupes paraissent accessibles en Angleterre E. Il faut pousser la question avec le géologue régional R.G. THURRELL brièvement entrevu. B. OWENS cite la coupe d'Ormsby qui recoupe le Quaternaire jusqu'à la craie et a fait l'objet d'une étude micropaléontologique détaillée (palynologie, dinoflagellés, foraminifères) dont la publication est prévue.

Au niveau national du Royaume Uni, B. OWENS enregistre un déficit global pour la formation de personnel qualifié, ce que le BGS compense par la formation interne. Il y a quatre pôles de formation principaux pour la micropaléontologie (peut être aussi la macropaléontologie) : Southampton, Aberystwyth, Univ. College Londres, Sheffield.

Aux autres questions soulevées, B. OWENS a apporté les réponses suivantes :

- collaboration BRGM-BGS : pas de problème de principe mais seulement de financements. B. OWENS est impliqué dans des J.V. internationales, notamment avec le Directorat du pétrole norvégien ;

- stratigraphie séquentielle : nouveau responsable, le Dr. A. WHITTAKER qui couvre stratigraphie et tectonique. D'après R.G. THURRELL, le BGS mène de tels travaux sur le Crétacé inférieur. Mais il y a probablement d'autres thèmes ;

- stratigraphie comparative par dinoflagellés. Beaucoup de travaux réalisés par le BGS sur le Mésozoïque (travaux publiés et disponibles à la vente) et sur le Cénozoïque (en cours). Les travaux concernent le bassin de Londres et le Hampshire. Le principe d'une collaboration pourrait être rediscuté dans la deuxième moitié de 1991.

7 - LABORATOIRE DES GÉOSCIENCES ISOTOPIQUES DE NERC (NIGL)

Les informations qui suivent proviennent du Dr. I.G. SWAINEBANK, en l'absence du responsable R.S. HARMON. Comme le montre la liste de l'annexe 9, le personnel comprend 17 personnes, dont 2 relèvent du British Antarctic Survey (BAS) et 3 du BGS.

Le NIGL a été séparé du BGS en 1987 et il fait partie des Services scientifiques de NERC, aux côtés des services informatiques, des navires de recherche, etc...(1).

Le NIGL dispose des lignes isotopiques suivantes : K/Ar, Rb/Sr, U/Pb, Pb/Pb, isotopes stables (S, O, C, D, H). Une ligne Sm/Nd va être réinstallée en octobre 1990. L'arrivée d'un spécialiste du monozircon va permettre de mettre en place la ligne correspondante. Sont également en projet les déséquilibres radioactifs et une ligne N. Il n'y a pas de ligne tritium.

Les deux membres du BAS présents dans l'équipe s'occupent uniquement de géologie de socle dans l'Antarctique (cf. 10.3). L'équipe du BGS s'occupe d'inclusions fluides. Elle est dirigée par T.J. SHEPHERD. Le tableau 2 donne la répartition par organisme et grand domaine des activités du NIGL.

On trouvera dans le rapport 1987-90 du laboratoire archivé à DS des indications plus détaillées sur les principales opérations. Une liste résumée est donné dans le tableau 3.

Le coût d'accès aux installations du NIGL est basé sur l'activité de 13 personnes du staff travaillant 213 jours par an. Le coût de base est celui de la demi-journée (5538 par an : 213 x 2 x 13), obtenue à partir d'un coût annuel de 1 077 800 livres (à diviser par 5538).

Ce coût est de 277 livres/jour comprenant 188 livres d'utilisation d'équipements et 89 comme coût de personnel.

En fait le financement du laboratoire est assuré par NERC qui impute les organismes demandeurs de services au prorata des demandes. Il n'y a donc pas de transfert de cash à partir des organismes. Ceux-ci doivent simplement prévoir les coûts correspondant dans leurs prévisions de programme et la régulation se fait d'une année sur l'autre (principe de l'impôt sur le revenu en France). L'intervention de personnel propre des instituts libère du temps pour les chercheurs du NIGL, qui peuvent ainsi assumer certains travaux propres.

On trouvera dans le tableau 4 des informations fournies par I.G. SWALNEBANK sur les autres laboratoires de géochimie isotopique de Grande Bretagne. La tendance générale de la recherche est l'utilisation des isotopes stables en sédimentologie et l'étude des processus du manteau.

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(1) Cf. la liste de tous les instituts et services communs de NERC en annexe 1 du rapport DS n° 53 du 20.02.1989, pp. 119-123.

TABLEAU 2

RÉPARTITION DES ACTIVITÉS DE GÉOCHRONOLOGIE ET DE GÉOCHIMIE ISOTOPIQUE DU NIGL PAR ORGANISME ET GRAND DOMAINE

Organisme	Pourcentage de l'activité totale	Domaine d'activité
BGS	40,7	Cartographie géologique (12 %) : Rb/Sr, Sm/Nd, monozircon en attente, très peu U/Pb classique Etudes de gisements (14 %) : Pb/Pb. Travaux à l'étranger (12 %) : Rb/Sr... Travaux scientifiques (2,6 %) : géochimie isotopique Sr...
Universités	39,4	Toutes méthodes, surtout isotopes stables ; radiochronologie en développement
BAS	18,1	Rb/Sr, Sm/Nd (Chaîne andine), composition isotopique glace ($^{18}O/^{16}O$, D/H)
Instituts de recherche marine et atmosphérique	1,4	Isotopes stables (S)
Institut de recherche sur les eaux douces	0,4	Exemple : étude de dépôts de calcite dans les cours d'eau

TABLEAU 3

PRINCIPALES ETUDES CONDUITES PAR LE NIGL PENDANT LA PÉRIODE 1987-90

- isotopes S dans des schistes bitumineux,

- isotopes Sr pour le projet HDR de Camborne,

- minéralisations Ba-Pb d'Ogmore et composition isotopique Pb de galènes du Pays de Galles,

- appui à la cartographie de Hong Kong (Pb-Sr sur granites) et datations de granites du Jiangxi (Chine),

- datation Pb-Sn et Sm-Nd de granitoïdes cadomiens de nord Bretagne (R. D' LEMOS, Oxford Polytechnic),

- étude d'inclusions fluides de pegmatites à spodumène du granite de Leinster (Irlande SE),

- géochimie isotopes O, Sr, Nd des laves du volcan Muriah (Java),

- études volcanologiques dans les Andes centrales,

- milieu de dépôt de carbonates glaciaires du Groenland E et du Spitzberg (Univ. Birmingham),

- étude d'isotopes du carbone dans les dépôts calcaires de Waterfall Bech (Yorkshire), Kings College London,

- datation Rb/Sr roche totale de mudstones paléozoïques du Pays de Galles,

- analogues nationales du croisement Portland et caractéristiques d'altérations. Etude par isotopes stables,

- géochimie manteau-croûte : isotopes O dans xénolithes du manteau (volcanisme Baïkal) et de faciès granulite de diverses localités mondiales, géochimie Sr-Nd-Pb-O de basaltes tertiaires et quaternaires du Massif central (Danielle BRIOT, Univ. Blaise Pascal), isotopes Sr-Nd-Pb-O-H de gabbros océaniques du leg 118 (Open University),

- études métallogéniques par inclusions fluides (BGS) : minéralisations du SW de l'Angleterre (géochronomètres Sm-Nd sur fluorines...), métallogénie Au en Ibérie centrale (projet CCE avec le SG du Portugal), caractérisation de fluides crustaux par les isotopes stables,

- datations K/Ar et Rb/Sr sur la Cordillère andine (Antarctique W, Argentine, Chili) par le BAS. Etude de la subduction et de l'éclatement du Gondwana.

TABLEAU 4

INDICATIONS SUR LES EQUIPES DE GÉOCHIMIE ISOTOPIQUE DE GRANDE BRETAGNE EN DEHORS DU NIGL

Université	Noms des chercheurs	Techniques
Cambridge	K. O'ONIONS	Sm-Nd
Oxford	S. MOORBATH P. TAYLOR N. GALE	U-Pb, Pb-Pb Pb archéologie
Leeds	B. CLIFF	isotopes radiogéniques, un peu stables
Liverpool	J. MARSHALL	isotopes stables
Newcastle	?	K-Ar
Scottish Univ. reactor centre	SURC	isotopes stables, monozircon
Royal Holloway and Bedford New College	M. THIRWELL + 1	isotopes radiogéniques

8 - LABORATOIRES D'ANALYSES

Le BGS dispose à Keyworth (Service de géochimie analytique dirigé par D.L. MILES) d'une large palette d'équipements d'analyse pour la géochimie minérale sur solides : Fluo X, absorption atomique, ICP, ICP/MS, fluorimétrie. Les analyses d'eau sont faites à Wallingford avec des équipements ICP et ICP/MS.

Pour les analyses organiques, le BGS possède deux chromatographes gaz (Philiips 4400) qui dépendent du Service de Géochimie analytique et un équipement de chromatographie en phase liquide haute performance (Waters) installé à FP.

Un commentaire à faire en matière d'ICP/MS, avec le développement en cours d'une recherche sur l'ablation laser dans le cadre d'une collaboration entre le BGS et le Département de Chimie du Birbeck College (Londres). Les interlocuteurs sont Colin FLINT (responsable), Simon CHENERY et Mike THOMSON (Dept. of Chemistry, Birbeck College, Gresse st., London W1). L'interlocuteur BGS sur ce thème est T. SHEPHERD.

9 - ACTIVITÉS À L'ETRANGER

A.J. REEDMAN a remplacé K. BLOOMFIELD à la tête de la division des programmes à l'étranger (Overseas) et c'est de lui que nous tenons l'information qui suit.

On trouvera en annexe 10 une liste des opérations du BGS à l'étranger en cours à la date du 2.04.1990. On rappellera que les programmes TC (Technical Cooperation) correspondent à des actions spécifiques faisant l'objet d'un accord bilatéral à court ou moyen terme et que le poste "R & D Programme" regroupe des actions de recherche qui n'ont pas cette contrainte bilatérale. Ces deux types de travaux sont financés par l'Overseas Development Agency (ODA).

Il n'y a en principe que sur ce poste de R & D que des coopérations BRGM-BGS sont possibles. A.J. REEDMAN ouvre la possibilité de travaux en commun sur les thèmes suivants :

1 - **études côtières** dans le SE asiatique et le Pacifique (zone CCOP-ESCAP) dans le cadre du CCOP Frame work Programme. Ce thème a été évoqué lors d'une récente mission à Bangkok de A.J. REEDMAN et il doit l'être à nouveau lors de la conférence des ministres de l'environnement de la région, qui doit avoir lieu à Bangkok du 10 à 16 octobre 1990, suivie du CCOP Technical Meeting (5-15 novembre 1990).

L'approche proposée est très pluridisciplinaire et concerne les problèmes de deltas, la géomorphologie côtière, la dynamique des processus côtiers, la sismicité et l'hydrologie (intrusions salines). Des travaux sont en cours sur des îles du Pacifique (Ron KETCHING). La ville de Djakarta aurait des problèmes de ce type. L'ADB soutient ce type de projet et A.J. REEDMAN pense que les problèmes de financement d'experts par l'ADB deviennent moins cruciaux : évolution politique de l'ADB, contribution partielle de spécialistes locaux ;

2 - **environnement et santé** dans les zones géothermales volcaniques. Suite à de travaux de type TC au Kenya, il y a une demande pour les Philippines et l'Indonésie. D'une façon générale, la demande de l'ODA est forte en matière d'études sur l'environnement. Cette évolution est destinée à relayer la baisse des études sur les ressources minérales. Exemple de thème : agrogéologie, en liaison avec l'ODNRI(1) et l'Université de Newcastle.

3 - **Hydrogéologie** : milieu de socle fracturé, recharge des aquifères de bassin sédimentaire : cf. projet STD envisagé avec Taïba.

(1) Cf. DS n° 26 du 1.02.1990.

10 - INFORMATIONS CONCERNANT D'AUTRES INSTITUTS DE RECHERCHE DÉPENDANT OU NON DE NERC

10.1 - INSTITUTE OF TERRESTRIAL ECOLOGY (ITE)

L'ITE dépend de NERC. Le contact suggéré par B. KELK est :

Dr. T. Michael ROBERTS (Director)
ITE
Monks Wood Experimental Station
Abbots Ripton
Huntingdon
Cambridgeshire, PE 17 2 LS
Tel : (0) 4873 3581
Fax : (0) 4873 467

10.2 - PLYMOUTH MARINE LABORATORY (PML)

Ce laboratoire, qui dépend de NERC, résulte de la fusion de l'institute for Marine Environmental Research (IMER) avec la Marine Biological Association of the UK (MBA).

Le contact suggéré par B. KELK est :

Dr. B.L. BAYNE (Director)
PML
Prospect Place
West Hoe
Plymouth PL 1 3 DH
Tel : (0) 752 222 772
Fax : (0) 752 670 637

10.3 - BRITISH ANTARCTIC SURVEY (BAS)(1)

Le BAS, qui dépend de NERC, a déjà été évoqué dans le chapitre 7 consacré au laboratoire de géosciences isotopiques de NERC (NIGL). Le BAS est un organisme pluridisciplinaire dont la composante "sciences de la Terre" est modeste : 10 géologues et géophysiciens permanents (+ 6 à 8 sur des contrats temporaires de 3 à 5 ans) sur un total d'environ 200 personnes.

La figure 5 présente la zone d'activité du BAS dans l'Antarctique, la figure 6, la répartition des domaines d'activité(2). Depuis 1983, le Gouvernement britannique à décidé de soutenir fortement l'activité en Antarctique, pour des raisons politiques (présence britannique dans la région) et scientifiques (qualité du laboratoire naturel). Le programme de 1983 est donné dans le tableau 5.

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(1) High Cross, Madingley Road. Cambridge CB 3 OET.
Tel : 0223 6 11 88
Fax : 0223 62 616
Directeur : Dr. David J. DREWRY.

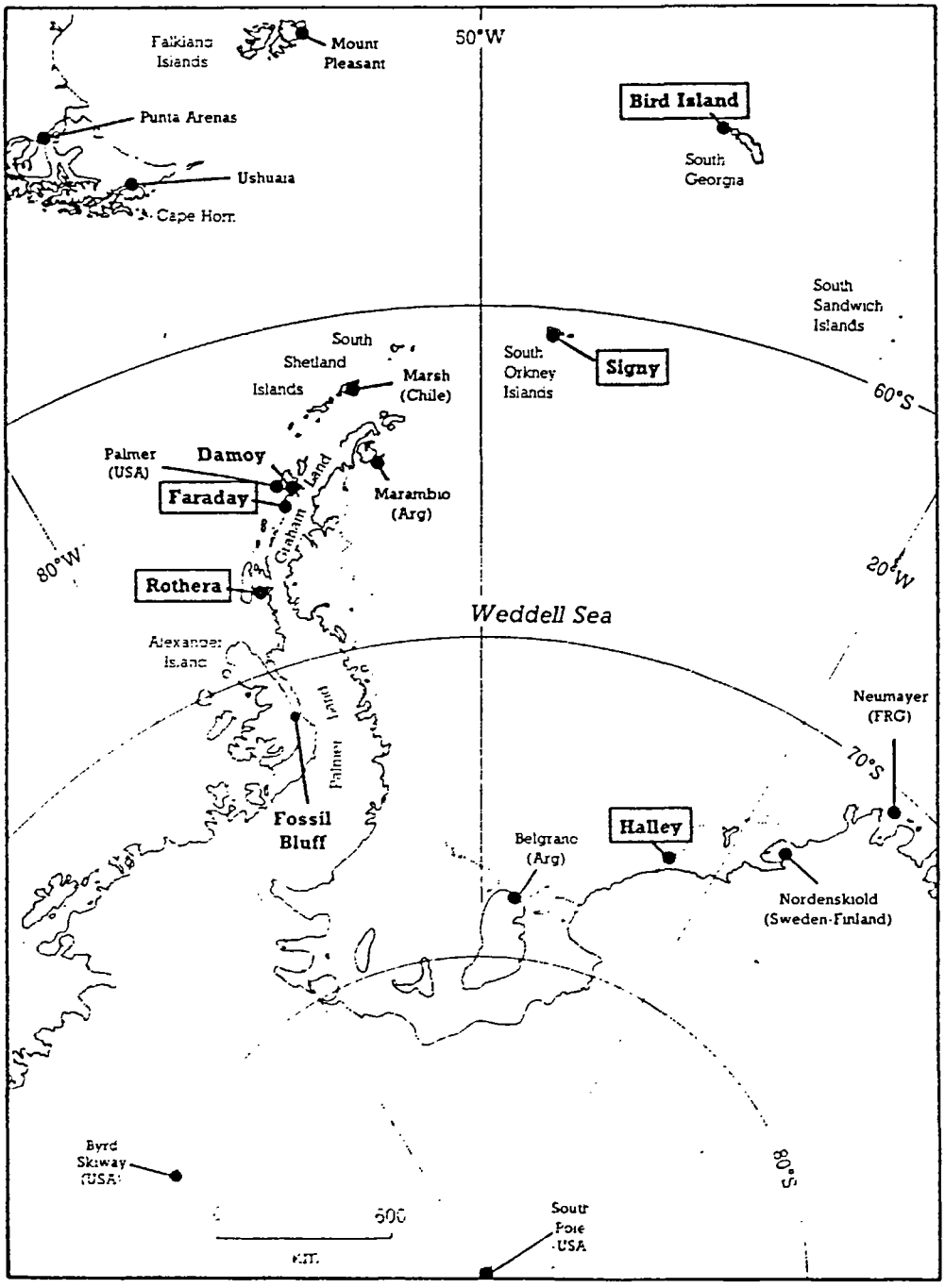
(2) Pour plus de détails, cf. le document Antarctica 2000 archivé à DS.

FIGURE 5

ZONE D'ACTIVITÉ DU BAS DANS L'ANTARCTIQUE

Source : Antarctica 2000
Archivage DS

Area of British Antarctic Survey activities. British Antarctic Territory extends between 80°W and 20°W south of 60°S. The five permanent BAS stations are shown in the shaded boxes. Summer-only bases are operated by BAS at Damoy and Fossil Bluff. Ten other nations possess stations in the Antarctic Peninsula region, many in the Southern Shetland Islands.



and component Programmes are shown. Letters refer to BAS Divisions

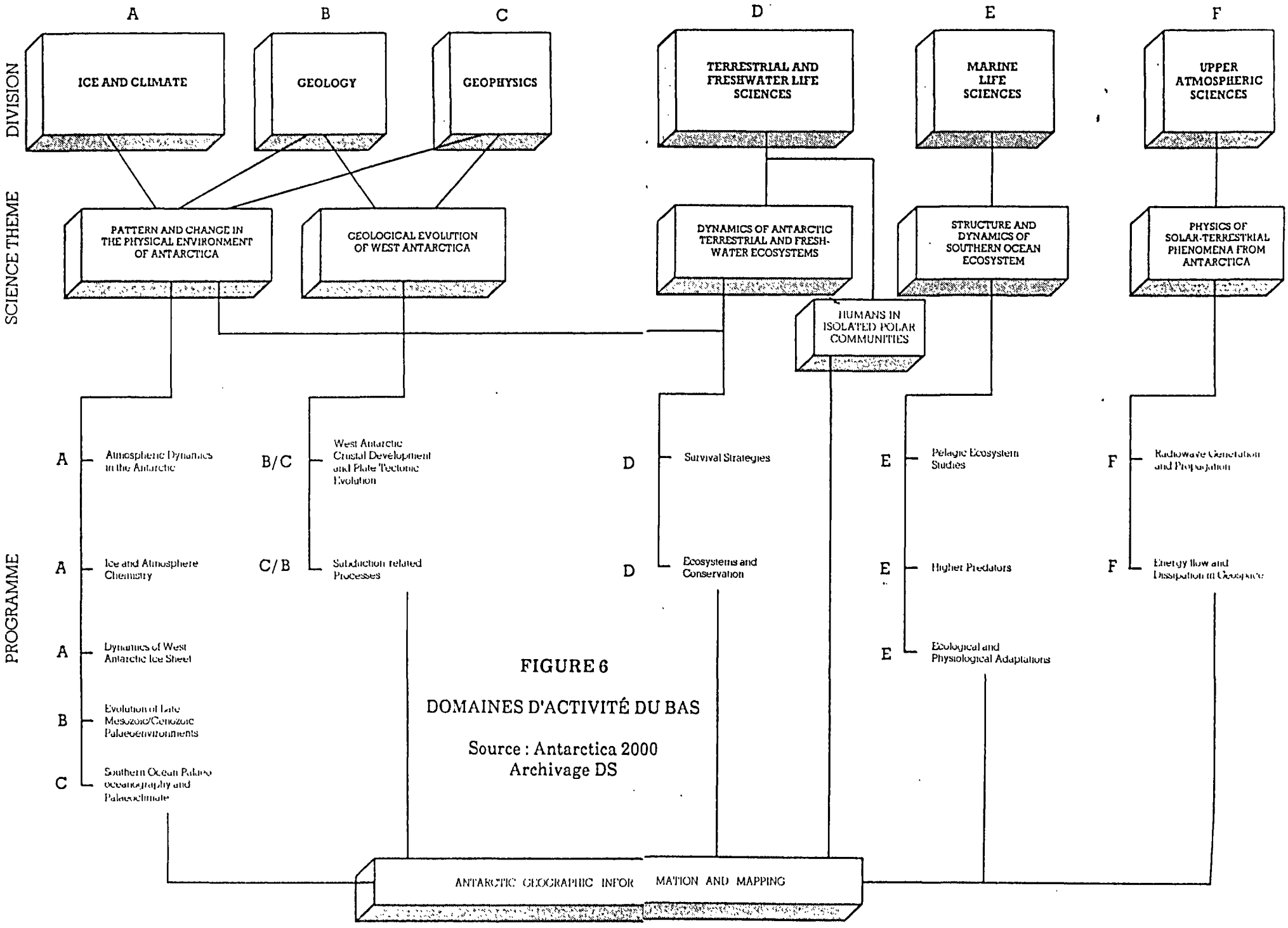


FIGURE 6

DOMAINES D'ACTIVITÉ DU BAS

Source : Antarctica 2000
Archivage DS

TABLEAU 5

PROGRAMME 1983 DU GOUVERNEMENT BRITANNIQUE POUR L'ANTARCTIQUE

1983 UK GOVERNMENT PLANS FOR ANTARCTIC SCIENCE EXPANSION

- **Earth Sciences (Geology, Geophysics and Glaciology)**

i) Completion of the reconnaissance geological and geophysical survey of the BAT landmass and continental shelf by 1993.

ii) Understanding the plate tectonic setting of this area related to the break-up of the palaeo-supercontinent of Gondwana

iii) Appraisal of the offshore hydrocarbon and onshore mineral prospectivity of the region.

iv) Understanding of the processes that control the stability of the Antarctic ice sheet and its response to climate change.

The above work was to involve the continued use of existing techniques including gravity, aeromagnetic and radio echo sounding, and development of new methods such as deep seismic reflection sounding, and satellite remote sensing. In addition the glaciological work was to pursue work on ice core analyses to reconstruct past climates and changing airborne pollution levels.

- **Marine Life Sciences**

i) Marine ecosystem studies, at a variety of scales, with the emphasis on zooplankton (principally krill) and related ecophysiological problems (eg, cold-adaptation and fat synthesis).

ii) Higher predator studies (seals and birds) to investigate breeding performance and energy flux between predator and prey including the investigation of squid populations.

The overall aim of the above programmes is to assess the living resources and the interactions within their ecosystems of the Southern Ocean with a view to their natural management or exploitation – such work is seen as providing the essential context for the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR), the role of which is the regulation of exploitation so as to maintain the ecological relationships between harvested and dependent populations, to predict the dynamics of biological systems likely to be impacted in the search for minerals or their exploitation.

- **Terrestrial and Freshwater Life Sciences**

i) Study of individual plant and animal species and micro-organisms of the widespread but sparsely populated Antarctic fellfield communities.

ii) Biological and physiological adaptations to rigorous environments with reference to processes of colonization, survival and ecosystem development.

iii) Prediction of environmental impacts on these communities arising from man-made land-based activities.

iv) Study of a diverse range of Antarctic lakes which provide "experimental chambers" for the investigation of chemical and biological-chemical interactions – difficult in lower latitudes.

- **Atmospheric Sciences**

i) Investigation of ionospheric and magnetospheric dynamics from mid latitudes to the plasmapause, to the auroral zone and into the polar cap

ii) Study of the three-dimensional nature of the solar wind moving supersonically through interplanetary space and, by observing the scintillation of celestial radio sources analysis and possible prediction of disturbances which give rise to geomagnetic storms, important for radio communication and geophysical exploration at high latitudes

iii) Investigation of Antarctic ice shelves of the stable boundary layer which develops during the winter period

iv) Upper air studies including stratospheric ozone

v) Three dimensional wind distribution, temporal evolution and atmospheric turbulence at heights up to about 20 km at South Georgia, using a 50MHz radar

La région est protégé par plusieurs traités internationaux :

1- Traité de l'Antarctique de 1959 ratifié en 1961, suite à l'Année Géophysique Internationale de 1957-58 ;

2- Mesures agrées pour la conservation de la faune et de la flore antarctique (1964) ;

3- Protection des phoques de l'Antarctique (1972) ;

4- Convention sur les ressources marines vivantes (CCAMLR, 1980) ;

5- Convention sur la régulation des activités concernant les ressources minérales en Antarctique (CRAMRA).

Les textes relevant des rubriques 2, 3 et 4 forment le système de traités de l'Antarctique (ATS).

L'instance principale de coopération internationale en matière scientifique est le Comité scientifique sur la recherche en Antarctique (SCAR), établi par l'International Council of Scientific Unions (ICSU) en 1958. Quelques grands programmes mondiaux ont une composante antarctique :

- World climate Research Programme (WCRP),
- International Geosphere Biosphere Programme (IGBP).

Suite à la mise en place d'une première mission en Antarctique (opération Tabarin), le BAS a été créé en 1961 et, en 1967, il a été placé sous la responsabilité de NERC.

En matière de sciences géologiques, les travaux sont focalisés sur l'évolution de l'Antarctique de l'ouest et plus précisément l'éclatement du Gondwana il y a environ 160 MA et la constitution de la Cordillère andine.

La recherche est organisée selon deux grands programmes :

- le développement crustal et l'évolution en matière de tectonique des plaques de l'Antarctique de l'Ouest ;
- les processus liés à la subduction.

L'aide à la recherche des substances minérales (à terre) et des hydrocarbures (au large) est sous-jacente à ce programme scientifique. Sur tous ces thèmes, le BAS collabore avec des équipes du Chili, des Etats Unis (Lamont, Univ. Texas) de Nelle Zélande, de RFA.

R.J. PANKHURST, que nous avons rencontré, est un des deux spécialistes du BAS détachés au NIGL. Les études géochronologiques sur l'Antarctique relèvent principalement de la méthode Rb-Sr sur roche totale ou minéraux, dans une moindre mesure Sm-Nd et K-Ar. Des travaux sont également réalisés en géochimie isotopique. Il n'y a pas de travaux en isotopes stables. Ces travaux concernent largement le magnétisme calco alcalin et le métamorphisme affectant les séquences mésozoïques.

L'équipe de géologue du BAS travaille aussi sur la reconstitution des climats à partir des données du Cénozoïque, mais le travail de climatologie se fait surtout sur la calotte glaciaire (nouveau forage de 500 m réalisé).

10.4 - SCOTT POLAR RESEARCH INSTITUTE(1)

C'est un groupe de plus petite taille que le BAS puisqu'il ne compte qu'une douzaine de personnes. Il est indépendant de NERC. Les travaux concernent beaucoup plus l'Arctique que l'Antarctique et également le Spitzberg.

L'Institut joue un rôle de soutien à la recherche conduite par des équipes scientifiques extérieures, auxquelles il apporte notamment un appui pour les navires de recherche.

10.5 - RÉPERTOIRE DES CHERCHEURS EN SCIENCES DE LA TERRE

Il existe un répertoire de la recherche publique en Grande Bretagne publié par la British Library. Les Sciences de la Terre sont regroupées dans la Physical Sciences Section qui comprend deux parties : index et recherche. La 4ème et dernière édition de cet ouvrage date de 1989.

D'une discussion avec le Professeur J. BRIDEN, Directeur Sciences de la Terre pour NERC, je retiens sa marque d'intérêt pour la mise en place d'un référentiel chercheurs/thèmes traités comme contribution du Royaume Uni à un réseau d'information européen. Les Services géologiques peuvent jouer un rôle dans l'établissement de ce référentiel et l'idée pourrait être proposée dans le cadre de WEGS.

11 - CONCLUSIONS

La cérémonie d'intronisation du centre BGS de Keyworth en "Kingsley Dunham Centre", du nom du directeur du BGS en poste entre 1967 et 1975 et qui a procédé au choix du site, a été l'occasion d'établir un premier diagnostic de thèmes de collaboration possibles entre le BGS et le BRGM. Ce choix de thèmes sera soumis au BGS pour avis courant août 1990, en précision d'une réunion de travail à Orléans la deuxième quinzaine d'octobre, au cours de laquelle ces thèmes pourront être discutés plus en détail.

Le tableau 6 présente le récapitulatif des thèmes d'intérêt commun fléchés.

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(1) Lensfield Road, Cambridge.
Ces quelques éléments d'information proviennent de la discussion avec R.J. PANKHURST.

TABLEAU 6

RÉCAPITULATIF DES THÈMES D'INTÉRÊT FLÉCHÉS POUR UNE COLLABORATION BRGM-BGS

Thèmes	Interlocuteurs BRGM	Interlocuteurs BGS	Remarques
Gestion des données du sol et du sous-sol	J.P. LEPRETRE A. COLLEAU	B. KELK	Le directeur du BGS a confié à B. KELK une mission de stratégie sur le thème de la gestion des données géologiques, de la cartographie thématique et des SIG
Cartographie thématique pluridisciplinaire	A. COLLEAU	B. KELK P. ALLEN	Expériences pilotes en cours au BGS, de même que faisabilité utilisation des données du 1/10 000
Gestion d'une cartothèque	P. LANNEZ J.P. LEPRETRE	J. BAIN	Application du logiciel CARTONET, standard adopté par la British Library
Processus géochimiques Pollution par les déchets Analyses de gaz Transport par colloïdes	J.F. SUREAU A. BOURG H. BONIN C. FOUILLAC	A. BATH G. WILLIAMS	Transfert de micropolluants métalliques et organiques Déchets industriels (dont radioactifs) et domestiques Dispositif BGS RESCAN de suivi de traçeurs
Approche pluridisciplinaire de la prospection minière et des études de gisements. Prospection de l'or (dont morphologie des grains) et des platinoïdes. Préconcentrations (notion de réservoir crustal)	H. ZEEGERS P. FREYSSINET I. SALPETEUR	J. PLANT, R. LEAKE (morphologie or), G. GUNN (platinoïdes)	Projet CCE agréé (appel d'offres matières premières minérales) Essais divers sous SYNERGIS
Minéraux industriels	P. LE BERRE L. GALTIER G. BAUDET	D. MORGAN	Perspective : appel d'offres CCE Matières Premières Minérales 1990-91. Nombreux thèmes : - applications techniques minéralogiques sophistiquées et études gîtologiques ; - délaminage ; - optimisation exploitation à l'aide de techniques informatiques ; - optimisation simulation procédés et gestion usines ; - optimisation des propriétés minérales pour des applications spécifiques. Synthèses minérales.

TABLEAU 6 (suite)

Thèmes	Interlocuteurs BRGM	Interlocuteurs BGS	Remarques
Géologie et géophysique marine	M. VILLEY P. GUENNOC S. DEBRAND-PASSARD	C. EVANS R. WINGFIELD	- Accès à données BGS - 1/1 000 000 France - Manche - méthodologie de cartographie côtière - Quaternaire Manche s.l.
Biostratigraphie Stratigraphie séquentielle	S. COURBOULEIX G. FARJANEL	B. OWENS R.G. THURRELL A. WHITTAKER	Etude du démarrage des glaciations quaternaires et plus spécifiquement de la dernière. Accès à des sites de Grande Bretagne. Essais comparés de stratigraphie séquentielle Bassin de Paris - Bassin de Londres.
Analyses ICP/MS	M. BORSIER A. BATEL	T. SHEPHERD en liaison avec équipe Birbeck College (Resp. C. FLINT)	Méthodologie ablation laser
Activités à l'étranger	DCG J.J. COLLIN P. MASURE	A.J. REEDMAN	Etudes côtières Asie - Pacifique. Environnement et santé dans les zones géothermales volcaniques. Environnement général. Hydrogéologie milieu de socle fracturé et recharge bassins sédimentaires
Répertoire européen des chercheurs en Sciences de la Terre	DS SGN	P. COOK ? En liaison avec J. BRIDEN (NERC)	Etablissement d'un répertoire de chercheurs/thèmes en vue partenariat pour actions de recherche et montage réseau européen.
Atlas phosphates	D. GIOT	P. COOK	Sélection d'études dans le travail de D. GIOT et regroupement des meilleurs cas de chaque équipe (RU, Australie, USA...) dans un ouvrage collectif.

ANNEXES

ANNEXE 1

DROITS D'ACCÈS AUX SOURCES D'INFORMATION ET DE CONSEIL DU BGS

BRITISH GEOLOGICAL SURVEY

Charges for information and advisory services

Natural Environment Research Council

April 1990

The British Geological Survey is the custodian of extensive collections of records, materials and data pertaining to the geology of the UK, its continental shelf and, indeed, many 'developing' countries overseas In addition, its staff, engaged on wide-ranging survey and research activities, provide a reservoir of both scientific expertise and local geological knowledge that is unmatched elsewhere The resources are available for consultancy purposes, research studies and general advice, provided charges are met for specific services

Those covered by this leaflet are largely standard charges for one-off enquiries; consultancy rates are the subject of negotiations or quotes for more extensive staff involvement or use of resources. Customers are invoiced for the charges incurred, for settlement within one month of receipt All charges are subject to VAT.

Operating policy

No charge is made for access to collections of formal publications held by the Survey, whether they consist of titles issued by BGS or have been acquired by purchase or exchange None is imposed for dealing with enquiries about the availability of information, services and products. Specific requests for details of holdings may, however, be subject to charge if considerable time is likely to be expended on retrieval procedures.

In the main, charges are levied for personal consultation of unpublished documents, the inspection loan and sampling of borehole core, rock samples and fossil specimens, the copying of records and the provision of geological advice. Rates are based on the cost of staff time involved in retrieving, collating, copying and evaluating data, **but also embody a 10% surcharge devoted to the maintenance costs of the collections themselves**

Where data supplied have incorporated an interpretative element contributed by BGS staff, e g in the classification of borehole material, charges may be made for the value-added component

General conditions

Information supplied by BGS is provided on the strict understanding that, in order to comply with ownership rights and any express conditions of deposit, it is used for the sole purposes of the customer and is not passed, in any form whatsoever, to a third party. No material may be reproduced in any form without the permission of the Director, BGS This does not preclude the use of such information by a consultant where it was sought for the purposes of satisfying a contract and subsequently incorporated in a report to the client. The use of digital data is subject to specific licensing and royalty arrangements determined by the application for which the data are sought.

In view of the disparate sources of data at the Survey's disposal, including much material from voluntary donations, BGS can accept no liability in respect of loss, damage, injury or other occurrence arising from the provision of geological information from its archives.

Inspection of survey documents

The main libraries and the London Information Office hold reference collections of large-scale maps and technical reports that do not constitute formal BGS publications but are available for public consultation. Such consultation is subject to a charge of £12 per half day (+ VAT) per visitor. Prior appointments are not essential but payment, against a receipt if required, is expected before leaving Local collections are held at regional offices, for these, visitors should make an appointment in advance

Regular visitors may ask for details of period-payment reader's tickets

Inspection of geological records

Visitors wishing to consult material in the extensive collections of geological records must arrange an appointment to ensure the ready availability of documents and that staff can be in attendance

Inspection fee = £25 per person per day (+ VAT), this charge to include the requisite set of documents for the stated location of the enquiry

plus £12 (+ VAT) for each further set of documents or area concerned (not exceeding the 5 x 5km² of territory represented by the site registers)

Access to core and samples

Appointments to view and/or sample core and related materials must be made in advance.

Inspection fee = £50 per person per day (+ VAT)

plus £25 (+ VAT) for each 50 m depth of borehole

Subject to prior authorisation, samples may be taken for testing and analysis. A charge of £10 (+ VAT) per sample is made to cover the cost of supervision, cutting, bagging and labelling

Recipients of samples must undertake to lodge with BGS any subsequent analytical or research data obtained from such material. A limited period of confidentiality will be respected if so requested Arrangements for access to the Biostratigraphical collections and conditions for the loan of fossil material are covered in a separate leaflet.

Geological advice and interpretation of data

Enquiries seeking geological advice or interpretation of data are subject to the standard advisory service charge. Requests dealing with particular localities should preferably be submitted in writing, accompanied by a marked-up copy of a map or by 8-figure National Grid references defining the area in question

Standard advisory service charge = £50 (+ VAT) for first hour of staff time

plus £25 (+ VAT) for each additional half hour or part thereof

The supply by BGS staff of interpreted information relating to boreholes, e g stratigraphical classification, is subject to a charge of £50 per 100m depth, with a minimum fee of £50 per borehole

Copying costs

Where photocopies of documents are provided, the following charges will apply

Up to A4 in size = 18p per sheet (+ VAT)
Up to A3 in size = 25p per sheet (+ VAT)

Prints from microfilm will be charged at 45p (+ VAT) per frame. Charges for microfiche and other photographic media will be supplied on request Copies of digital data on magnetic tape, and printouts from computer databases are subject to specific quotes for the amount and type of information supplied

Visitors may pay for photocopies on the spot A minimum charge of £7 50 (+ VAT) is made for mailing photocopies in response to a telephone or postal enquiry If such a request involves much processing of documents, staff handling costs, pro rata at £25 (+ VAT) per half hour, will be charged **in addition** to the photocopying costs themselves

Despatch of documents

Packages of documents or samples sent through the post will be subject to postal charges in operation at the time Express parcel despatch is available on request Copies of documents can be forwarded by facsimile transmission at an additional charge of £1 (+ VAT) per A4 sheet

Discretionary arrangements

For academic research, BGS may be prepared to adjust or waive charges The cost of copying or despatching material will not normally be waived, and free inspection of collections will be limited to ½ day per person per visit unless otherwise authorised by the relevant Collection Manager. The relevant Head of Department must confirm that any information supplied will not be used for commercial purposes, a pro-forma is available for signature. Sampling charges may also be waived in favour of a refundable deposit, although this may be deferred if the samples are returned, or copies of the research results and analytical data lodged with BGS, within six months of the commencement of the loan Where samples are prepared from core material and involve the use of rock-sawing facilities, the operational costs, at about £1 per sample, may be charged to the recipient.

The deposition of data in the Survey's archives by other organisations is encouraged and a quid pro-quo agreement for waiving charges will be considered if a formal exchange of data is negotiated.

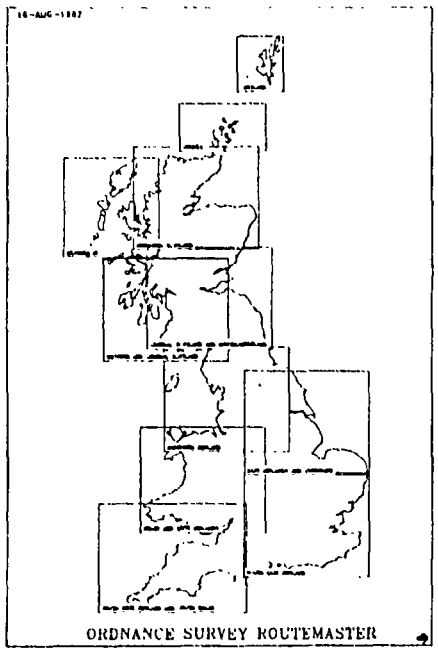
Operation

These charges are effective from 1 April 1990 until further notice.

Queries

Queries regarding the above charges and conditions applying to waivers should be directed to the Manager, National Geosciences Data Centre, British Geological Survey, either at Keyworth or Edinburgh (Murchison House)—refer to list of offices for addresses and telephone/fax numbers

All charges embody a 10% levy devoted to archive maintenance. Payments are subject to VAT



Short map records are generated with the graphic index, up to 200 fields are available for each map sheet in a complete CARTO-NET record

ORACLE NUMBERS:	18:371
SERIES.	Ordnance Survey Route-master Series of Great Britain
RESPONSIBILITY:	Ordnance Survey
PUBLISHER.	Ordnance Survey
SCALE.	Scale 1 250 000
SHEET NO.	8
SHEET.	South West England and South Wales
EDITION	(Ed)8
DATE	1979

The CARTO-NET package includes GEOLINK and GEOZOOM software, the data input screens, Validation and Help facilities.
Optional facilities:
Interactive searching using the Ordnance Survey 1:625000 digital map coverage of Great Britain.
Other digital data sets incorporated by arrangement.
Linkage of World Gazetteer Database to map catalogue.

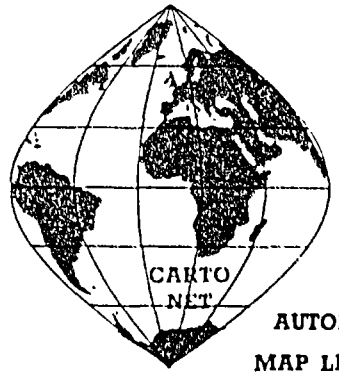
FURTHER INFORMATION

For a current price list and further information please contact:

Barbara Morris
Department of Geography
University of Edinburgh
Drummond Street
Edinburgh
EH8 9XP
United Kingdom

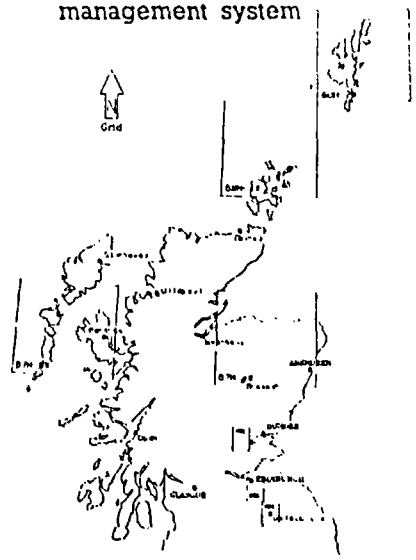
Tel: 031 667 1011, Ext.4391

Developed in the Department of Geography, University of Edinburgh, with the support of the British Library.



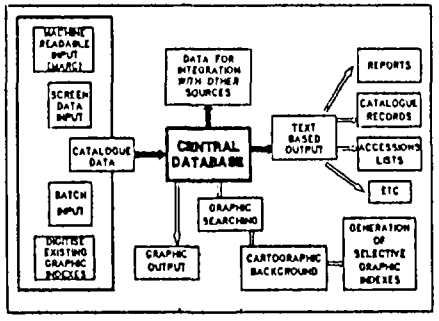
AUTOMATED MAP LIBRARY

Graphic retrieval and management system

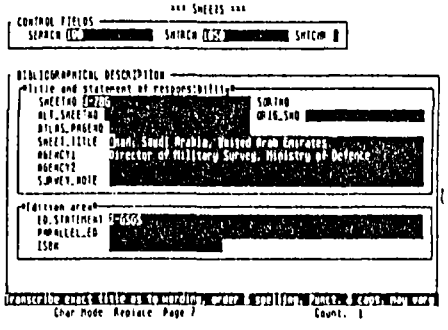


Scottish Geology Maps 1 50000 & 1 250000

CARTO-NET



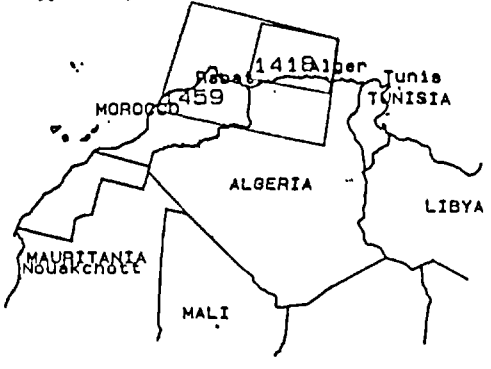
1. Catalogued according to the Anglo-American Cataloguing Rules (2nd edition).
2. An enhancement of the UK MARC format, accommodating map SHEETS which are part of a SERIES.
3. Records are convertible to other MARC formats.
4. Complete bibliographical control of map sheets which are part of a SERIES.
5. On-line graphic searching and display.
6. VALIDATION and VERIFICATION on many fields.
7. On-line HELP at all Levels.
8. Co-operative cataloguing network under development.



Sample CARTO-NET input screen.

Offers interactive graphic searching.

Interactive zoom; more topographic and place-name detail appear at larger scales.



May be linked with Gazetteer entries, air photographs and satellite imagery.

Designed to answer the most common map library queries.

CARTO-NET– Main Menu

Sample Options

1 – Graphic searching
2 – Search by National Grid for U K (box or point)
3 – Search by Latitude/Longitude (box or point)
4 – Search by Country, Scale (and Date)
5 – Search by Urban area, Scale (and Date)
6 – Search by Subject
7 – Search by Shelfmark
8 – Search by Interest
9 – Search by Topographic Feature (from Gazetteer)
10 – Search by Town name (from Gazetteer)
11 – Search by Series

18 – General Purpose Search
19 – Utilities
20 – Quit from search

Cataloguing, screen editing and full catalogue records are available through the secondary menu.

CARTO-NET– Utilities Menu

Sample Options

1 – Create a view for short catalogue entry
2 – Screen editing
3 – Access a complete record
4 – Return to main menu

The flexibility of CARTO-NET allows tailoring to suit individual collections. CARTO-NET currently uses the British Library Map Library Subject Headings. More detailed thesauri could be substituted for specialised collections, e.g. the British Geological Survey.

ANNEXE 3

A Menu Aided Retrieval System (MARS) for use with a Relational Database Management System.

K A M Adlam and P G Robson.

The British Geological Survey has recently standardised on the Oracle system as its DBMS. An ever-increasing number of scientists have need of access to the data that is being stored in this environment, but many of them are not prepared to spend time learning either how to program in SQL, or how to use the complexities of the SQL-Forms interface. The most efficient access for such a community is through a character driven (not screen) menu system. A system has now been designed and built such that it functions as a complete shell to not only the database system, but the entire computing environment. This shell is so designed to permit the storage of context-sensitive help information, which is then accessible by the user from any position within the menu system. Applications have been built which permit the user to transparently query the database, pass the result to another package, and then display the final result, all from within the menu system. The final result may be tabular, or graphical (if run from a suitable device). Previously many of these applications could only have been built using a language such as Fortran. They can now be built in a fraction of the time using the Mars shell. Although developed on a VAX VMS system for Oracle, there is no design reason why this system should not be ported to any other DBMS using SQL, on any other operating system (for example, Unix on a distributed network).

INTRODUCTION.

1 Historical Background

The British Geological Survey (BGS) is a component body within the Natural Environment Research Council (NERC). A primary function is the collation and dissemination of geological information into the community, according to customer demand. Customers include government departments and industrial concerns. Consequently, a major part of the Surveys work is the storage and management of data, in a variety of forms.

The development of the menu system described in this paper grew out of requirements which are a long-standing feature of the 'classical' geological use of data. The scientists in this category of users are predominantly field geologists working in the Land Survey division, and not naturally a group familiar with the everyday use of computers. The data they handle is a mixture of text, numeric (both integer and real), dates, etc, drawn from bore hole registers, site investigation reports, sample descriptions, as well as an archive detailing past services rendered by the BGS to its customer base.

Until 1983 the digital handling of this type of data was by purpose-built Fortran programs, referencing (usually) direct access files. All processing functions depended on an application program being written. Needless to say, all the typical epithets of the dp 'backlog' applied in full to this situation.

As the size of the data files increased, and with it the time taken to access the data, alternative data handling methods began to be explored. The BGS database section investigated the application of modern database software to the Survey's dp problems. The result was a decison to move into the relational database field with the Swedish product Mimer. Immediate benefits included use of a query language, greatly improved access to large data sets via indexes, and faster generation of input/output software modules using that product's own 4GL (a combination of a SQL-like query language embedded into a procedural language). The long-term benefits of a more rational design were recognised, but were of course yet to be realised.

For a variety of reasons, BGS decided in late 1987 to move its entire database environment from Mimer to Oracle. The data translated from one environment to the other without difficulty. However, very considerable problems arose with the movement of the application functions. Oracle provides an SQL implementation, but no

procedural language within which to embed the set-based operations of SQL. The only way to recover this functionality was by building Fortran applications with embedded SQL code. For the number of applications which the Land Survey had already built with the Mimer procedural language, this was a wholly unrealistic option.

2 The User Environment.

Database applications written for the Land Survey are long lived, being used repeatedly over an extended period of time. A large collection of software modules has been built up, any of which may be required at any time. It consequently becomes important to document this software, to provide easy access to it, as well as to actually manage it on the central processor (ie maintenance, access permissions, etc)

It was tentatively suggested that a procedural language was now no longer required in the face of a full SQL implementation, and further, that the scientific community could easily start writing SQL programs for themselves, thus further diminishing the need for application programs written by specialist staff. The reality was that neither of these two premises were valid. The 'backlog' (in the form of database functions previously provided) re-asserted its presence again.

The essence of the problem as it then existed may be stated as follows. There are two components in the system.

> First, a scientific community anxious to take advantage of the benefits of modern database management software, but only where that might be done with maximum efficiency and minimum disruption to their existing commitments.
>
> Secondly, a sophisticated interface to the database (SQL), together with a variety of processing tools external to the database which could be usefully exploited only by skilled and competent specialists.

The problem was to provide a bridging mechanism which would enable maximum use of the database for minimum input from the programming staff.

Fundamental to the loss of the application-building environment in Mimer was the loss of an easy way of generating a menu interface. Consideration was given to the Oracle product SQL*Menu, but the advantages of this product did not match the design requirements for the BGS system. It was therefore decided to embark on an exploratory project to build the required software infrastructure in-house.

DESIGN PARAMETERS.

1 Overview.

The design of this system was not concerned with those members of BGS who can work competently with SQL (a small minority). The intent has been to provide an interface which demands the very minumum of command input from the user. In this respect our approach varies from that described by Lucas [3], whose spreadsheet interface does expect a certain skill on the part of the user. A user of Mars may ignore the command options and interact in an entirely passive mode if so desired.

It was also designed on the basis that installed applications would have a medium to long-term existence.

From an early stage the tight inter-dependence between 'data' and 'application' to access that data was recognised. Both are seen as primary elements of the DBMS environment. There is a third component of the DBMS which was regarded as of equal importance -documentation. Our initial design positively integrated

these three components into a mutually interdependent environment.

Table 2.

Main Startup Menu for BGS (STARTUP)

1 - DOCUMENTATION for Databases and Mars

2 - DATABASE Menus

3 - Utilities

4 - MARS Screen, insert & update Menu entries

5 - Personal USER menu (if defined)

-?

SYSTEM COMMANDS

1 Starting Mars.

Because Mars is a Fortran task which calls Oracle, all users must submit their Oracle name and password when first starting the system. A root menu is then displayed. It is from this point that all subsequent activities take place. As well as permitting the user to choose from the displayed options, there are a large number of commands which can be submitted to the system from the prompt.

2 Moving between Menus

The user may jump out of the current menu to any other menu as long as the user knows the name. (This has given rise to the convention of always stating the name of the menu in the display header information attached to each menu -see Table 2 -the menu name here is STARTUP). Thus the concept of a strictly imposed menu hierarchy need not exist -one can choose to remain within the constraints of a particular hierarchy, or jump arbitrarily forward or backwards in the same one, or jump out into an entirely different hierarchy.

3 Special Menus.

Certain menus are identified as type-menus. The first entry menu which all users see is given the system name of the TOP menu. The user can jump back to this menu from any position within the system simply by entering 'T' at the menu prompt. Similarly, users may re-define their own chosen entry menu as one other than the TOP menu, and again this menu can be accessed with a single letter command ('E' for Entry). A personal menu with the same name as the user's Oracle id may also be established. This menu can be reached from any position with the command 'U' (for User).

4 Commands

Just as these commands can be submitted from the keyboard when running the program, so they can be held as commands for execution against a particular menu option number. Multiple commands can be strung together. It is often the case that following completion of a successful SQL query, control should move on to a new menu -this can be done by attaching an additional command (the 'jump' command) after the last of the process commands.

5 Interactive SQL commands.

SQL commands may be submitted directly from the menu prompt. This feature permits the experienced user to check a part of the database contents, before initiating a menu option which might, for example, set off a lengthy batch job.

6 Operating System commands

Commands can be directed to the host operating system from the menu prompt -in the present implementation on a Vax any legal VMS command can be so entered, without dropping the Mars environment. A host session can also be run continuously from within Mars.

Operating system commands can be included as part of the menu command(s), either on their own, or as part of a composite of SQL and OS commands. The design ability to enable any one menu option to consist of a number of such commands is a feature which has very much appealed to the user community. Menu options can now be set up to carry out very specific functions. Admittedly the same functionality could be achieved in the past, but in a far less convenient fashion, and then only by a person sufficiently familar with the characteristics of the individual software components.

Inevitably, the issue of an operating system command results in the spawning of a task, which can mean a slight delay before the command commences. This is most evident where SQL*Forms applications are called up from a menu option. However, Oracle Version 6 is believed to offer a means of calling screens directly from within a Fortran task, which will eliminate the current small delay.

The Vax screen-based system editors can be called directly from the Mars task, without the necessity of setting up a spawned task.

7 Interactive Help

Help, or documentation concerning each menu and its attendant options can be summoned from the prompt. The commands are simple and straight forward -'H1' would display to the terminal all information that had been previously inserted for option 1, and so on for H2, H3 etc. General information on the menu itself can be obtained by entering 'H*'.

The command fields for any menu option may be inspected interactively. Entering 'Ln' (where 'n' is the number of the option of interest) would display all the commands for that option. Further, where a command included the execution of a system command file, that file would also be listed to the terminal (subject to user access priveleges).

FUNCTIONALITY.

1 Complex multiple commands

It is not possible in a paper of this length to detail the full range of commands and their individual functions. (See the User Guide, [4]). A broader view can be obtained by indicating the type of functions that have currently been built with the system.

The simpler concepts of moving about a menu hierarchy have already been covered. Processing becomes a little more complex where a number of connected commands are linked together into one menu option. For example, one such option could decompose into the following parts:

a) route control to a menu to set the current terminal type (VT100, VT200, Tek 4010 etc).
b) return control to the original menu
c) prompt the user for an output data file name,
d) run an SQL database query outputting to that file,
e) reformat that file with a Fortran application,
f) prompt user for print fileoutput device
g) print the re-formatted data file

- all by choosing one option from a menu.

The SQL component of the above command sequence could be further broken up into several parts. By use of internally defined variables, Mars can display a 'menu' which consists of a list of fields which may be displayed. The user would then pick those fields by entering the reference (in the preferred order of display) numbers allocated in the list (eg 5,7,12,9). A further menu could be used to pick the fields against which a select criteria was to be exercised. Again, another menu might offer alternative boolean operators to be applied to the select fields. Finally, the user would be promted to enter the values against which the selection criteria were to operate.

In this manner relatively complex SQL queries can be generated in real time by a user without any knowledge of how to code in SQL.

2 Accessing external packages.

A similar process of functional menus and variables can be used to create system command files, and to populate them according to choices picked from menu listings. This technique has already been used to spawn tasks which access SAS, resulting in the display of graphical results to the terminal (assuming the user is running a suitable terminal device). As before, all query input and graphical parameters are generated by Mars following selections made by the user from a succession of menus. The graphic is then displayed without any further user input being required. Finally, the user is returned to the original menu from which the whole process was started.

It is by use of features such as this that a user can access the facilities of a variety of quite distinct process tools, all from the consistency of the same interface environment. This has great advantages for a user community not prepared to devote time to learning how to access a multiplicity of different applications. Apart from providing greater functionality to the user, it tends to restore the confidence of that sort of individual in what is otherwise sometimes regarded as a black art.

DOCUMENTATION.

The presence of documentation within the system is regarded as a critical feature. So often documentation is the afterthought in system construction, frequently because it is such a labour to adopt a new procedure for building documentation after working in an application construction environment. That is why a deliberate attempt has been made to demonstrate parity between 'documentation' and the 'command'. As far as the Mars system design is concerned, they are treated equally.

The means of building documentation is exactly the same as the method used to build the command systems. This is a deliberate attempt to try and encourage the application builder to document the commands as they are being built.

FUTURE DEVELOPMENTS OF MARS.

As further work is done using the Mars system to build applications, there is emerging the frequent use of it as a means of bundling several discrete applications into one transparent function. Data is passed from one environment to another, often through the relatively unsophisticated device of an ASCII file, but nevertheless obtaining the design aim of transparency. This data interchange standard also provides a degree of flexibility which might not otherwise be present.

Work so far has achieved the linking of Oracle to SAS and GKS graphics, to stand-alone Fortran tasks as well operating system utilities and command file macros. Mars can also provide transparent access to more than one DBMS by means of its use of standard SQL. It is hoped to develop links to database report-writing software, to enable the automatic generation of system documentation for any one menu or menu hierarchy, or indeed of any part of the information system.

Computing facilities in BGS are moving towards the widespread use of local area networks. This will provide an opportunity to use Mars to provide users with transparent access to multiple tasks distributed across multiple processors. The subsequent use of X-Windows and a graphical user interface will present one of the most exciting areas in which to extend further developments.

Although the current implementation is bound to Vax/VMS and Oracle, there is no reason why the software might not be ported to other operating systems running other database systems, providing SQL were present. It seems quite likely that a port to Unix will be addressed before long, given the inevitable appearance of Unix as a component of our developing local area network systems.

From a general standpoint, the authors would emphasise an aspect which will form the keystone in any future development of the product. This is the underlying design philosophy -an attempt to provide a bridge, shell, or user interface between a sophisticated machine environment on the one hand, and a non-programming user community on the other. The Mars system is not just a menu interface -it is an interface which was designed to address a particular type of user community.

[The views expressed in this paper are those of the authors, and do not necessarily represent those of the BGS.]

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Scotland, UK.

FOURNITURE PAR L'ORDNANCE SURVEY DE DONNÉES CARTOGRAPHIQUES DIGITALISÉES

ID/S/14

SUPPLY OF DIGITAL CARTOGRAPHIC DATA

Notes from meeting at ordnance Survey, Southampton 9 March 1990 with D Latham-Warde (Marketing Manager O.S.) and J A Bain and T J Dhonau (BGS).

PRICING POLICY

Although prices should take into account the cost of digitising, the potential number of customers and an element of "what the market can bear" only the first two are given cursory attention. Initially, consideration was given to recovering the data capture costs by outright "guaranteed" sales to four or five Public Utility companies. The alternative, an annual licence, was set at about one-third of the outright purchase price. This is now thought to be too small a differential and a quarter, fifth (or even less) of the purchase price will probably be set in future. In fact it is more likely that the sales price will be set correspondingly higher (as a disincentive to outright purchase) or even withdrawn altogether. Future income will be derived more from the provision of updates, against a licence, than direct sales.

Large scales

Vector data are supplied per standard area cell as follows:

1: 1250	0.5 x 0.5 km block	)	Outright purchase £110 + VAT
1: 2500	1.0 x 1.0 km block	)	Annual licence £33 + VAT
1:10000	5.0 x 5.0 km block	)	

There is also a charge for the media used - £20 per a 9 track ½" magnetic tape (max of 60 map blocks), £40 for a Unix ¼" data cartridge (max of 120 map blocks) or £10 for a PC 5¼" or 3½" floppy disc (max of 3 map blocks).

Updates can be supplied, costed as follows: £48.50 for 1 to 25 units of change in the data; £59.50 for 26 to 50 units of change; £70 for 51 to 150 units of change; etc. Updates are provided automatically, at no additional cost, under the annual licence fee (based on a 20 unit change threshold). All subject to VAT.

A plot program (D09) is provided free of charge to allow in-house plotting.

Very few 1:10,000 maps are available in vector format. O.S. appear to have discontinued hand digitising and data are being derived from larger scales. It is acknowledged that this may not be entirely satisfactory and that the absence of contours is a major omission.

Raster data, largely for the 1:10,000 series, are being offered as a stopgap by Alper Systems under an agreement with O.S. Current price, outright purchase, is £45 + Vat for each 5 x 5 km block. Larger scales can also be provided at £35 + VAT for each 1 x 1 km block at 1:2,500 or each 0.5 x 0.5 km at 1:1250 scale. Resolution is only 200 dpi.

Small scales

Marketing policy is now to charge an annual licence for data which includes the supply of updates and is loaded by a "customer use factor" calculated as a percentage of the basic fee. This factor is set individually for each customer and depends on the use being made of the data, eg the number of terminals and sites, reproduction of data, hard copy output etc. This includes the royalty fee for copying and printing out for internal use - equivalent to the fee currently paid by users of O.S. maps for photocoying (based on an estimate of amount done).

1:625,000 scale

Previous offer of two complete national datasets at outright purchase now withdrawn. Basic annual licence (before loading) varies from £105 for coastline dataset to £1115 for communications dataset; regional coverage of all datasets costs £105 for each 100 x 100 km block and all datasets for whole country coverage £1,620. Cost of supply medium is extra. All subject to VAT.

1:250,000 scale

To be supplied on 50 x 50 km blocks, annual basic licence fees yet to be determined. It would probably be advisable for BGS to follow suit and use the same blocks for compatibility, - and converting from the UTM projection. O.S. would be more than willing to cooperate on trials for the latter.

1:50,000 scale

To be supplied in 20 x 20 km blocks but vector digitising still at trial stage. Contour data and digital terrain model data are available, however, for a basic annual fee (before loading) of £27 + VAT for 20 x 20 km blocks of each data set. North of England and Scotland yet to be completed.

CONTROL OF USE

O.S. now have a formal licence form, with a reference number, for signature by both parties - see attached copy. This grants use of the data by the licensee according to an agreed schedule of use. The annual fee includes the provision of updates and copyright royalties for internal use (ie on the customer's premises). The customer is invoiced annually and specific regulations apply on termination of the licence - including the destruction or removal of data from the licensee's system. O.S. even insist on right of access to the licensee's premises to check compliance with the regulations.

The licence does not cover publication of map products derived from O.S. data. This is the subject of separate negotiations for royalty payments.

COLLABORATION

Joint ventures with other parties are limited (if marketing licenses to sell digital data derived from O.S. maps are excluded). The most obvious one is that with the A.A. on autoroute (to which the A.A. has added additional features to O.S. information); costs in this case are shared. It is unlikely that O.S. would see much value in a joint venture with BGS on production of digital cartographic data but they would be willing to collaborate on ensuring compatability between datasets and areal coverage.

James A Bain
13 March 1990

ANNEXE 5

RÉSULTATS DE L'ENQUÊTE DU BGS SUR LES UTILISATEURS DE CARTES GÉOLOGIQUES

USER REQUIREMENTS FOR GEOLOGICAL MAPS

Information from User Survey

Customer interests

Although not only concerned with maps, most users of BGS geosciences information fall into the following main customer categories :

Consultants or consultancy firms	28%	=	55% "private sector"
Industrial/commercial firms	27%		
Academic institutions	16%		

Civil engineering firms comprise about a quarter of the consultants, with a further quarter being engaged on mineral exploration and applied geology; the remainder consist of a mixture of disciplines from planning and intelligence services to legal advice. About a quarter of the industrial and commercial firms are engaged in minerals exploitation and a further quarter on energy resources. Other major business interests include the construction industry, manufacturing (cement, bricks, glass, ceramics) and technical or analytical services.

Only 7% of customers derive from central or local government (excluding the large commissions). Some 5% would be designated as public authorities, 5% as museums and galleries and 2½ as libraries. About 3½% would be classed as private individuals and the remaining 6% as miscellaneous categories.

Subject matter

Again, although not related only to maps, topics of interest are revealing for thematic needs. Some 53% of respondents expressed a direct interest in Land Survey products, taken to mean traditional geological maps and memoirs, but not far behind was Engineering Geology, 49%, and Environmental Geology, 48%, with Mineral Exploration at 43% and Water Resources at 34%. Geophysics was of direct interest only to 27% of respondents, with all other topics, such as Geochemistry,

Hydrocarbons, Marine Geology and Remote Sensing less than 20%. A large number of users rely on interpreted or "implied" information from traditional geological maps and would probably prefer to have thematic or applied geology maps - especially if customised products?

Scales

Over 87% of respondents would use 1:50,000 scale sheets, with 63% according these a high priority - suggesting that the main published output of the Survey is still important to users of maps. However, not far behind is the importance of large scale 1:10,000 maps, 80% of respondents showing an interest in these maps, with 58% according them a high priority. This would reflect a high professional requirement for local detail, a need evidenced by high demands for access to, or copies of, such sheets - even old County 6" versions.

Surprisingly, about 68% of respondents indicated an interest in 1:25,000 scale sheets, although only about 30% would accord these a high priority. Of much less importance were the 1:250,000 series, some 53% of respondents showing some interest but only 15% according them a high priority.

Other scales were of very minor interest.

There are, however, considerable differences in priority ratings between one customer category and another. Consultants place a greater emphasis on 1:10,000 scale maps - 70% according these a high priority - than on the 1:50,000 series - 60% giving these a high priority. For industrial companies, the comparative figures are 53% and 60% respectively while for academic institutions the figures are 41% and 76% respectively. In central/local government and public authorities there is rather less emphasis on map products, with 57% placing a high priority on the 1:10,000 scale maps and 46% on the 1:50,000 series.

Only 5% of consultants would place a high priority on 1:250,000 scale maps.

Published format

About 77% of respondents indicated that they would buy flat sheets and 49% would buy folded and cased versions. This indicates a 3:2 ratio in favour of the former and accords with sales of maps in practice. Despite the increasing costs of folding and casing evidently there is still a customer demand to satisfy for this version. Although production costs would be reduced by introducing an "integral" frontispiece and dispensing with the laminated card cover, Ordnance Survey experienced an overwhelming customer resistance to such a product when introduced on a trial basis for topographic maps.

Suggested improvements

A considerable number of respondents offered suggestions for improvements or criticisms in current map production, and reference should be made to individual returns. Most adverse comments referred to slow rate of production and inadequate geographical coverage - especially the need to extend and complete the coverage of the UK for 1:50,000 and 1:10,000 sheets. There were many pleas for more "up-to-date" information, revisions and "awareness" of where current surveying was in progress. Also requests for more recent topographic bases and/or perhaps overlays for specific information. Some requests merely reflected personal needs or preferences, eg display of well sites, roads and motorways, soils and geomorphological features, etc. One or two mentioned a need for better cartographic standards, but did not provide details.

Some comments referred to improved quality of production, eg in dyeline copies (which fade) or the use of more durable paper, or to new products - including bound volumes of 1:50,000 maps!

There was no expressed need for cartographic information to be made available in digital form - although views on this aspect were not specifically sought.

Geographical areas

Regional areas of interest gave equal prominance to Northern England, the English Midlands and Southern England - between 54% and 57% of respondents for each. Scotland and Wales were not very far behind, each with 46% of respondents professing an interest. Only 24% of respondents expressed an interest in offshore areas and 15% in Northern Ireland (although the latter may have been adversely influenced by a poor return for the questionnaire from this quarter).

A significant number of respondents (20% of the total) indicated an interest in overseas maps with a wide range of countries - refer to separate list for details.

J. A. Bain
23 Aug 1979

FIGURE 7

Map type preference

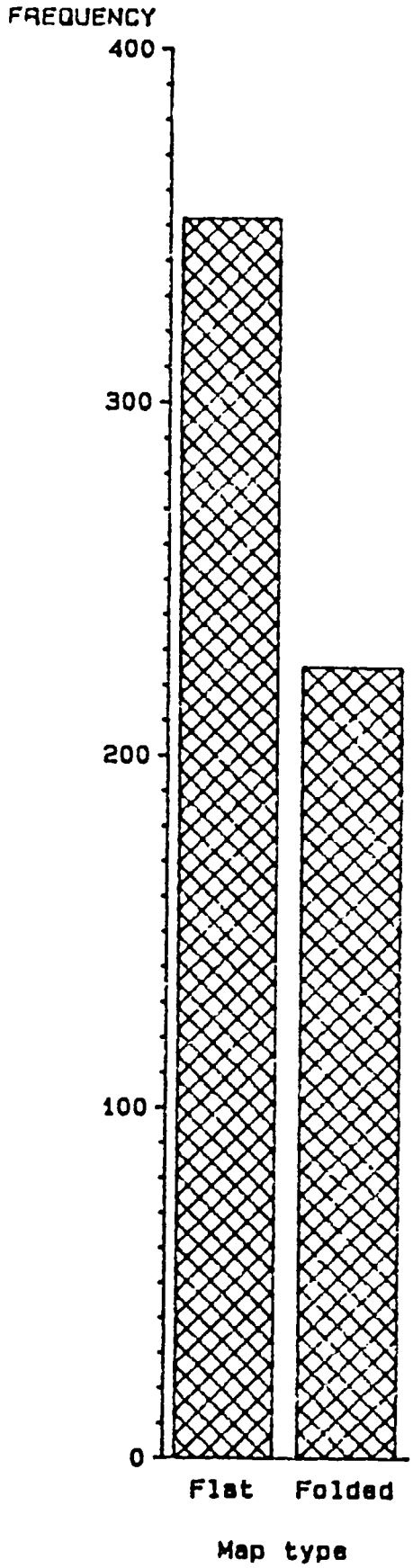
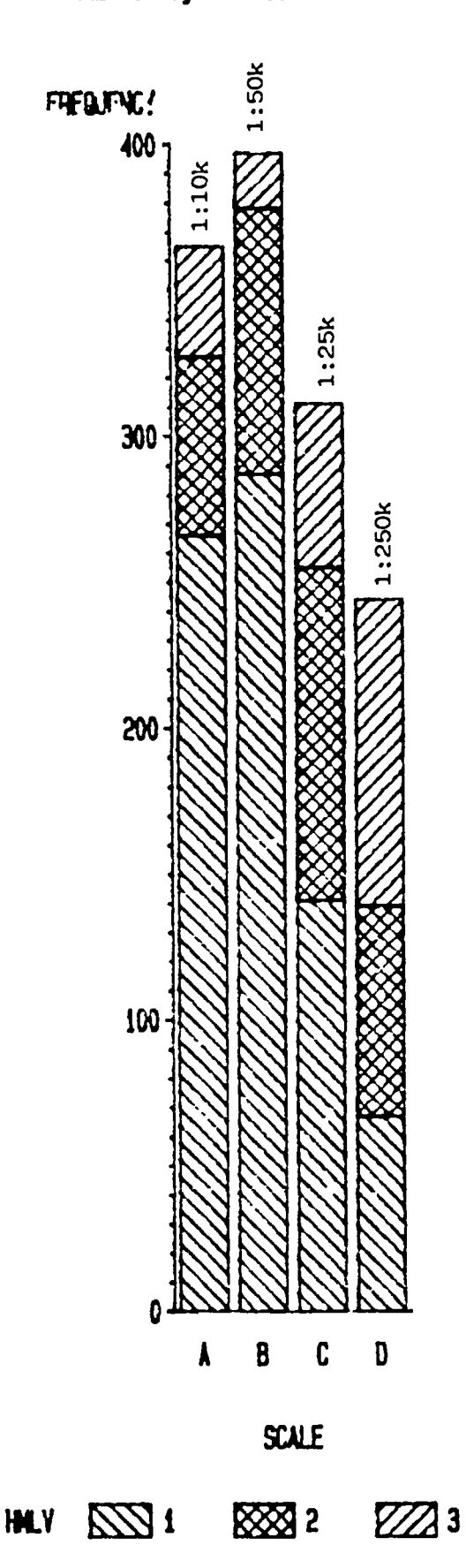
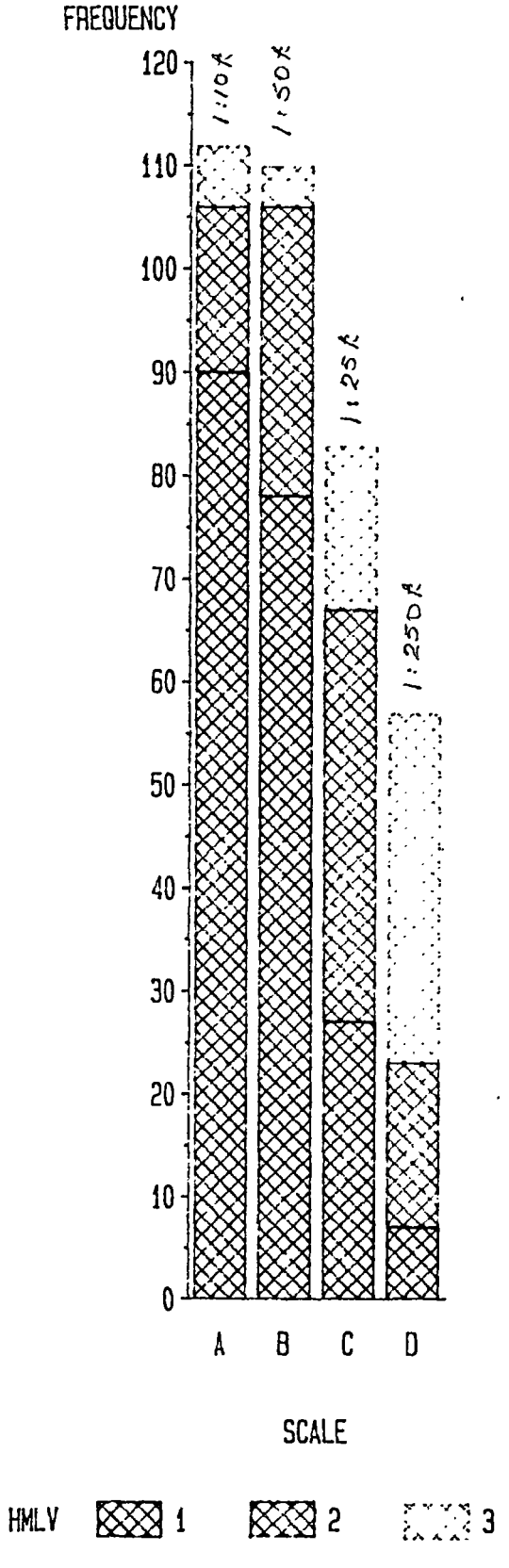


FIGURE 6


Scales of Interest
HMLV 1-High 2-Medium 3-Low
FREQUENCY
400
300
200
100
0
1:10k
1:50k
1:25k
1:250k
A
B
C
D
SCALE
HMLV
1
2
3

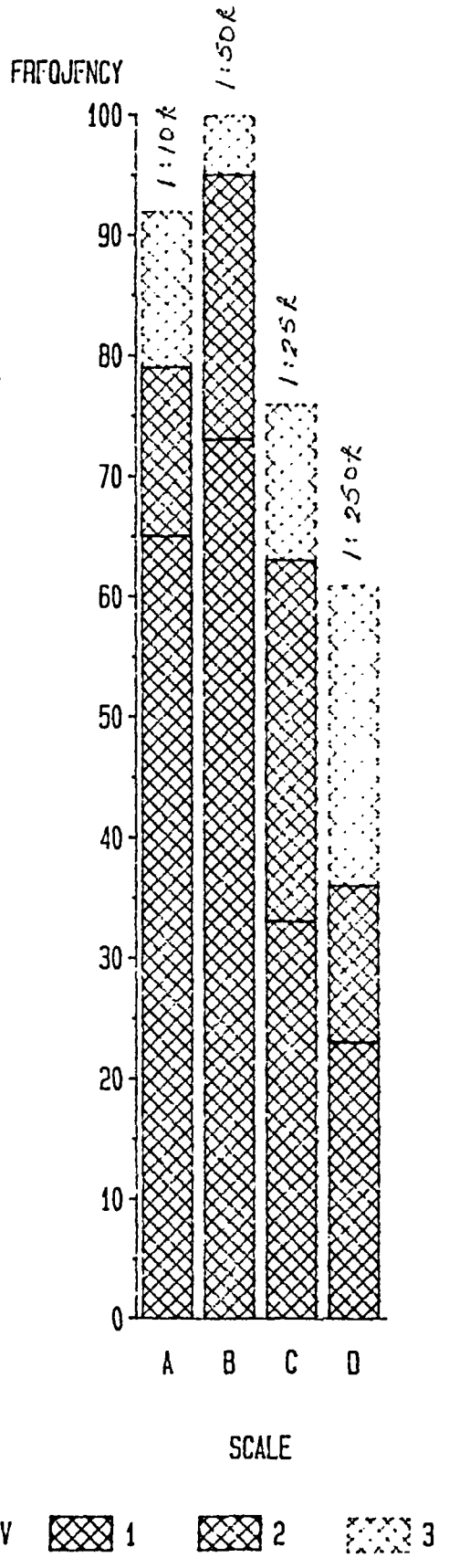
Scales of Interest – Consultants

HMLV 1=High 2=Medium 3=Low priority



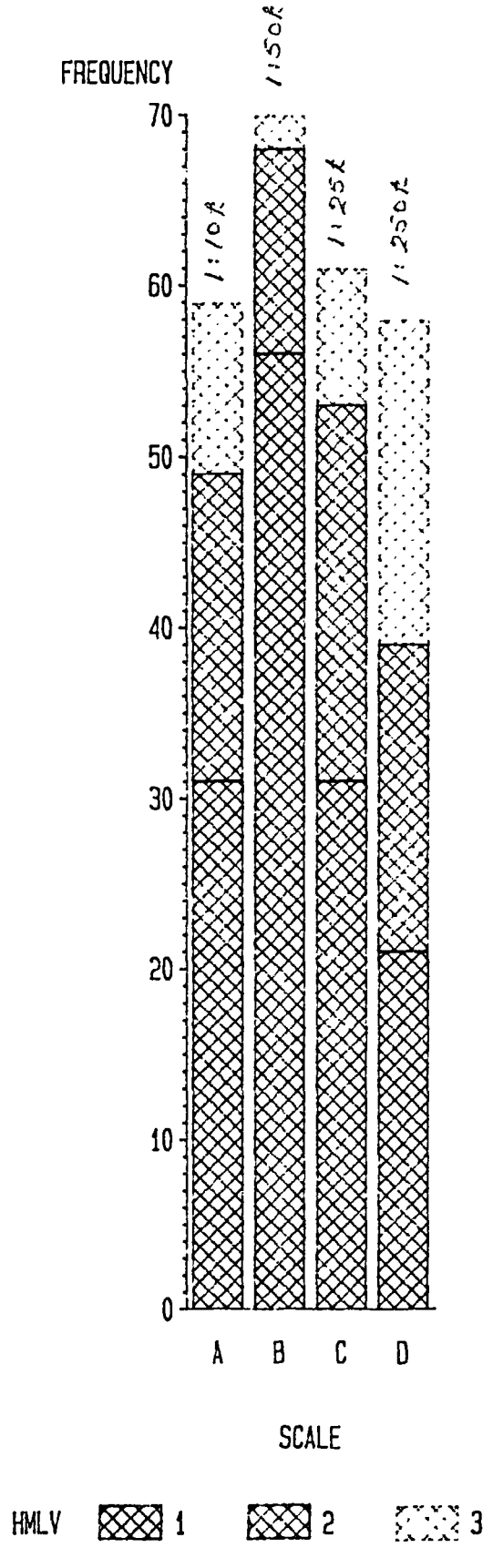
Scales of Interest – Industrial

HMLV 1=High 2=Medium 3=Low priority



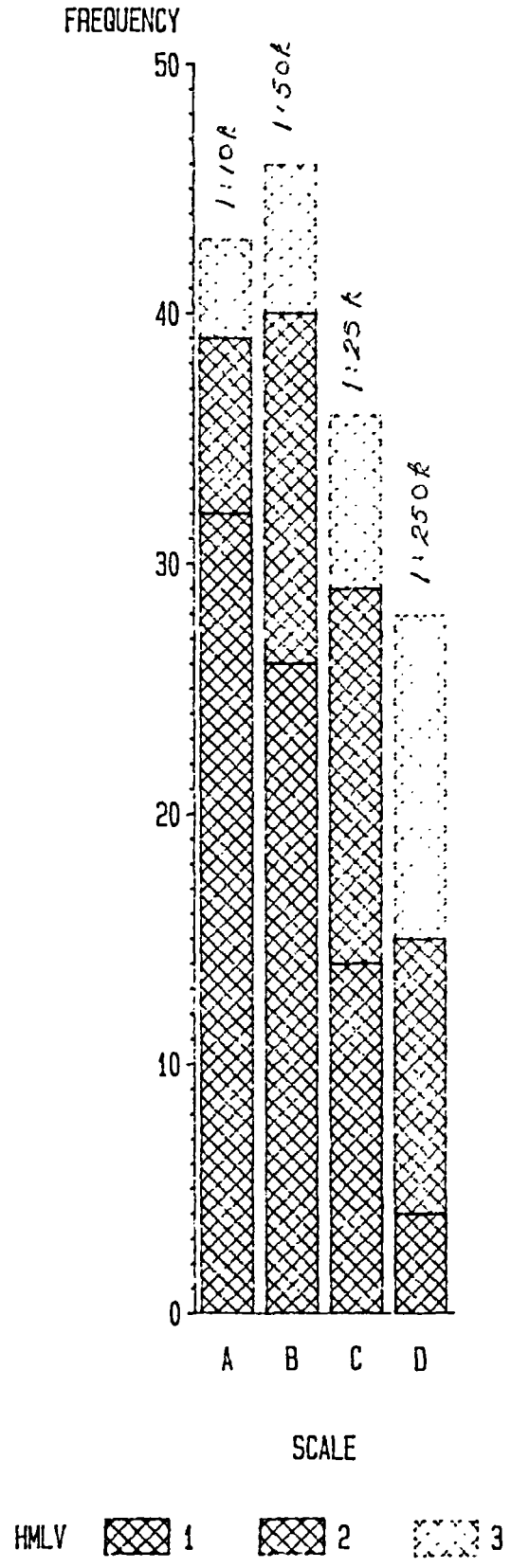
Scales of Interest – Academics

HMLV 1=High 2=Medium 3=Low priority



Scales of Interest -- Goverment

HMLV 1=High 2=Medium 3=Low



THE BGS RESISTIVITY SCANNING SYSTEM -RESCAN

BACKGROUND

A multi-electrode computer controlled electrical resistivity system, or ***RESCAN,*** *has been developed jointly by the Fluid Processes and the Regional Geophysics Research Groups of the British Geological Survey, initially as a means of automatically monitoring the movement of electrically conductive tracers such as sodium chloride, in groundwater tracer studies.*

RESCAN *technology, however, can be applied to many geological and hydrogeological, problems and some of these are listed overleaf.*

MEASUREMENT OF RESISTIVITY

(or reciprocal of electrical conductivity)

The ability of rocks to conduct an electric current is dependent primarily on the amount, and electrical conductivity of water within the rock. Saturated rocks have lower resistivities than unsaturated rocks. The higher the porosity, and the higher the electrical conductivity of the porewater then the lower is the resistivity. The presence of clays and conductive minerals also reduce the resistivity of the rock. Cavities and voids if air filled have a high resistivity.

The simplest way to measure electrical resistivity is to pass a current through two electrodes placed in the ground and to measure the potential difference across a second pair of electrodes placed in between. By increasing the spacing of the electrodes the depth of the measurement increases. In conventional geophysical surveys electrodes placed in the ground are connected manually or by mechanical switches to the current source and voltage measurement device, which is slow and laborious.

INNOVATION OFFERED BY RESCAN

In ***RESCAN*** *each electrode can be electronically selected and controlled by software to either pass current or measure potential. Any number of electrodes can be added to the system, for instance in the form of 2-D surface arrays or as long plastic insulated probes with many electrodes along their length installed in the ground. Such 3-D arrays can be used to determine ground resistivity in exceptional detail. Accuracy is achieved by iterative measurement continued until errors are maintained within a statistically pre-defined range. This allows various physical properties of the medium to be directly determined. Resistivity data or derived parameters may be displayed using 3-D tomography which may be built up in real time during surveys. The advantages of the system are :-*

- *The ability to accommodate large numbers of electrodes*
- *The ability to select electrodes and pass current in any direction by means of software*
- *The speed of measurement*
- *The accuracy of the measurement*
- *The compatibility of the data storage architecture with existing graphics displays/ processing systems.*
- *The wide number of applications using different probe designs*

PROBE DESIGN

Applications depend on appropriate electrode arrays; these are being built to suit particular applications of any scale.

APPLICATIONS OF RESCAN

Resistivity has found many applications in the past but the immense detail now possible with multiple electrodes arrays and rapid scanning opens up a new realm of possibilities. These are a few which have been identified. Please contact BGS to discuss whether ***RESCAN*** *can help in your specific application.*

HYDROGEOLOGY

- *monitoring contaminant migration in the saturated and unsaturated zones eg around landfills*
- *For assessing the integrity of emplaced clay or puddled chalk landfill liners, or natural containment barriers.*
- *Detection of leakage through membrane landfill liners*
- *Monitoring solvent migration in groundwater*
- *Monitoring saline intrusion in coastal aquifers.*
- *Fracture identification, and tracer tests in fractured rock.*
- *Monitoring the capillary zone above the water table and changes in soil moisture.*
- *Measuring vertical flows in boreholes*
- *For Redox profile measurement in the saturated and unsaturated zones*

ENGINEERING GEOLOGY

- *Monitoring landslips where water content triggers instability*
- *Identifying voids, cavities and shafts*

HYDROLOGY

- *River flows by dilution gauging and direct velocity measurements*
- *Monitoring mixing of saline and fresh water in estuaries*

GEOLOGY

- *For delineating faults*
- *determining glacial stratigraphy in 3-D*
- *For identifying burial channels*

ARCHAEOLOGY

- *Tomographic imaging of buried features*

DATA PROCESSING, DISPLAY AND INTERPRETATION

Data processing packages are available for on-site display using portable micro-computers. More powerful processing facilities are available at BGS for interactive volume modelling to display 3-D and 4-D realisations of the field data. BGS provides a full back-up consultancy service to provide expert interpretation in all aspects of earth sciences, and in surface water hydrology through its complementary research body the Institute of Hydrology.

CONTACT FOR FURTHER DETAILS

Geoff Williams	*Fluid Processes*
Peter Jackson	*Regional Geophysics*
Richard Ogilvy	*Regional Geophysics*
Rob Ward	*Fluid Processes*

BRITISH GEOLOGICAL SURVEY,
KINGSLEY DUNHAM CENTRE,
KEYWORTH, NOTTINGHAM NG12 5GG
Tel 06077 6111 FAX 060774 841

ANNEXE 7

PUBLICATIONS 1980-1989 DU
FLUID PROCESSES RESEARCH GROUP

THE FLUID PROCESSES RESEARCH GROUP

PUBLICATIONS AVAILABLE

FOR

GENERAL SALE

(1980 - 1989)

Contact:
Sales Office
British Geological Survey
~~Nicker Hill~~
Keyworth
Nottingham
NG12 5GG

Tel: (06077) 6111
Telex 378173 BGSKEY G
Fax 060 77-6602

ENPU REPORT SERIES - 1980

80-1	The geology of the Strath Halladale-Altnabreac district (W T McCourt)	March 1980
80-2	Borehole drilling details and survey data for the Altnabreac Site (B C Lintern & M G Raines)	April 1980
80-3	Reconnaissance geophysical surveys at Altnabreac Caithness (M K Lee & M L Richards)	April 1980
80-4	Preliminary results of hydraulic conductivity testing at Altnabreac Borehole A1 A (Soil Mechanics Ltd)	April 1980
80-5	The geology of some United Kingdom nuclear sites related to the disposal of low and medium level radioactive wastes - Part I UKAEA & BNFL Sites (N S Robins)	April 1980
80-6	A preliminary account of the hydrogeology of Altnabreac (S J Glendining)	April 1980
80-7	The distribution co-efficient (Kd) concept and its applicability to studies of radionuclide migration in geological media (I G McKinley & P B Greenwood)	April 1980
80-8	Fracture analysis of the rocks of the Altnabreac area (T J McEwen & B C Lintern)	April 1980
80-9	The geology of some United Kingdom nuclear sites related to the disposal of low and medium level radioactive wastes - Part II (N S Robins)	June 1980
80-10	Geomorphological predictions with respect to the Altnabreac area, Caithness (J D Peacock)	July 1980

80-11	Fracture analysis of crystalline rocks: field measurements and field geomechanical techniques (T J McEwen)	July 1980
80-12	Geochemical factors controlling the nuclide release source term in granite: dissolution of the waste form (D Savage & N A Chapman)	July 1980
80-13	Geomechanical properties of rocks from the Altnabreac area (T J McEwen, S T Horseman & S F Lai)	June 1980
80-14	Geology of the Altnabreac Research Site, Caithness (B C Lintern & B C Storey)	July 1980
80-15	Regional setting of the Strath Halladale Granite from gravity and aeromagnetic data (M K Lee)	Dec 1980
80-16	Magnetic, VLF and seismic surveys at Altnabreac (M K Lee, et al)	Dec 1980

ENPU REPORT SERIES - 1981

81-1	A geological reconnaissance study of the Dyfi Valley Region, Gwynedd/Powys, Wales (B A Martin et al).	Jan 1981
81-2	Hydrogeological reconnaissance study: Dyfi Valley Wales (S J Glendining)	Oct 1981
81-3	Hydrogeological reconnaissance study: Worcester Basin (J H Black & J A Barker)	Dec 1981
81-4	Hydraulic testing of deep boreholes at Altnabreac: development of the testing system and initial results (D C Holmes)	Jan 1981
81-5	Guide to data preparation for EQ3/6 (Wolery) modified for the IBM 3033 (D J Noy)	Nov 1981
81-7	Geochemical factors controlling the nuclide release source term in granite: engineered barriers for high level waste (P J Dudson & N A Chapman)	June 1981
81-8	Geochemical factors controlling the nuclide release source term in granite: rockwaste interactions (D Savage)	Nov 1981
81-9	Borehole drilling and completion details for the Harwell Site (N S Robins, B A Martin & M A Brightman)	June 1981
81-10	Porosity measurements of crystalline rocks by laboratory and geophysical methods (J Alexander, D H Hall & B C Storey)	Dec 1981
81-11	Geophysical borehole logging at Altnabreac, Caithness (D M McCann, K T Barton & K Hearn)	Aug 1981

81-12	Geochemistry of the rocks of the Strath Halladale - Altnabreac District (B C Storey & B C Lintern)	Sept 1981
81-13	Alteration fracture infills and weathering of the Strath Halladale granite (B C Storey & B C Lintern)	Dec 1981
81-15	Hydrogeological reconnaissance study; Somerset Basin (J Alexander & D J Noy)	Dec 1981

ENPU REPORT SERIES - 1982

82-1	A generic study of groundwater movement in the vicinity of an engineered shallow trench disposal site (D J Noy)	March 1981
82-2	Regional geophysics of the Cheviot area (M K Lee)	Jan 1982
82-3	Geological formations on the UK continental Shelf in relation to the disposal of solid-radioactive waste (C D Evans & D Evans)	March 1982
82-4	Hydraulic testing in granite using sinusoidal wave method (J H Black, D C Holmes & D J Noy)	Sept 1982
82-5	Repeated leaching of a simulated borosilicate waste glass (J E Robbins & D Savage)	Sept 1982
82-6	Sorption/desorption properties of argillaceous strata from boreholes at Harwell, Oxfordshire (I G McKinley and J M West)	April 1982
82-7	Basic geotechnical properties of core from the Harwell boreholes (S Horseman, P Hobbs, T J McEwen, L Avery and A Forster)	Dec 1982
82-8	Geomicrobiology and its relevance to nuclear waste disposal - an annotated bibliography (J M West, I G McKinley & N Christofi)	Aug 1982
82-9	Design and evaluation of the Harwell borehole cement systems (N S Robins & A E Milodowski)	Oct 1982
82-10	An analysis of in-situ stress measured by hydro-fracturing and the use of the borehole televiewer at Altnabreac (T J McEwen)	Oct 1982

82-11	Swelling properties of the mudrocks of Harwell (P R N Hobbs, H Yeow, S T Horseman & P D Jackson)	Dec 1982
82-12	Groundwater geochemical studies at the Altnabreac research site (R L F Kay & A H Bath)	Dec 1982
82-13	Mineralogical and lithochemical studies of strata beneath the Harwell research site (R D Wilmot & D J Morgan)	Nov 1982
82-14	Petrography of the Cretaceous core from the Harwell research site (A E Milodowski, B A Martin and R D Wilmot)	Oct 1982
82-15	Development of computer models for 3-D analysis of groundwater flow and mass transport (D J Noy)	Dec 1982
82-16	Geology of the northern part of the Strath Ossian granite, Scotland (W G Henderson)	Dec 1982

FLPU REPORT SERIES - 1983

83-1	The local groundwater regime at the Harwell research site (J Alexander & D C Holmes)	Jan 1983
83-3	Consolidation properties of the mudstones from the Harwell boreholes (T J McEwen, P Hobbs & S T Horseman)	March 1983
83-4	The geomicrobiology of the Harwell and Altnabreac boreholes (N Christofi, J M West, J E Robbins & I G McKinley)	Jan 1983
83-5	Temperature profiles in the Harwell boreholes (N S Robins, A Thomas-Betts, J S Gebski & A Sartori)	March 1983
83-6	A study of long term (10^3 - 10^4y) elemental migration in saturated clays and sediments (A B McKenzie, R D Scott, I G McKinley & J M West)	March 1983
83-7	Groundwater discharge mapping at Altnabreac by thermal infra-red linescan surveying. (N R Brereton & D H Hall)	July 1983
83-8	Case study of a containment site - The Hooton Landfill, Cheshire (G M Williams & I B Harrison)	Jan 1983
83-9	The Petrography of the Jurassic core from the Harwell Research site. Part 1. Kimmeridge Clay, Corallian Beds and Oxford Clay (A E Milodowski & R D Wilmot)	March 1983
83-10	The groundwater regime of the Harwell region, (J Alexander)	Dec 1983
83-11	Geophysical Logging of the Harwell Boreholes (M A Brightman)	August 1983

83-12	Guide to the field analysis of groundwater (S P Hitchman)	Dec 1983
83-14	Stratigraphy of the Harwell Boreholes (R W Gallois & B C Worssam)	Dec 1983

FLPU REPORT SERIES - 1984

84-1	Finite element modelling of the groundwater flow around Harwell (M A Brightman and D J Noy)	Jan 1984
84-2	Granite-water interactions at 100° C, 50 MPa: an experimental study (D Savage)	Jan 1984
84-3	The geochemical interactions of simulated borosilicate waste glass, granite and water at 100-350°C and 50MPa. (D Savage)	April 1984
84-4	The geomicrobiology of calcium montmorillonite (Fuller's Earth). (J C Philp, N Christofi and J M West)	Jan 1984
84-5	The geomicrobiology of used and disused mines in Britain (N Christofi, J M West, J C Philp and J E Robbins)	March 1984
84-6	The hydrochemistry of the groundwater flow systems in the Harwell region (J Alexander)	Dec 1984
84-7	Hydrogeological investigations in the Harwell region: the use of environmental isotopes, inert gas contents and the U decay series. (J Alexander and J N Andrews).	Dec 1984
84-8	Geochemical constraints on the microbial contamination of a hypothetical UK deep geological repository (J M West, P J Hooker & I G McKinley)	August 1984
84-9	Geomicrobiology and its relevance to nuclear waste disposal - a further annotated bibliography (J M West and S C Arme)	July 1984
84-10	A case study of a landfill in a shallow limestone aquifer near Banbury, Oxfordshire. (L S Alexander)	Jan 1984

84-11	A study of long-term (10^3 - 10^4 yr) elemental migration in saturated clays and sediments, Part II (A B MacKenzie, R D Scott, I M Ridgway, I G McKinley and J M West)	Jan 1984
84-12	CYLTRAN: finite element programs for flow and mass transport under cylindrically symmetric conditions (D J Noy)	Nov 1984
84-13	Assessment of techniques and media in the enumeration of micro-organisms from a landfill site (S P Hitchman)	Nov 1984
84-14	Determination of the geotechnical properties of mudrocks from geophysical logging of the Harwell boreholes (S T Horseman, D McCann, M A Brightman & T J McEwen)	Nov 1984
84-15	Borehole sampling techniques in groundwater pollution studies (A Stuart)	May 1984

FLPU REPORT SERIES - 1985

85-1	The geomicrobiology of European mines relevant to radioactive waste disposal (N Christofi, J M West & J C Philp)	Jan 1985
85-2	Dissolved helium, inert gases, radium and radon in groundwaters from the Altnabreac Research Site (J N Andrews & R L F Kay)	Jan 1985
85-4	Computer codes for three dimensional mass transport with non-linear sorption (D J Noy)	March 1985
85-5	Mineralogical and geochemical controls on heavy metal pollution in monolith lysimeters (R Newman & C A M Ross)	April 1985
85-6	Pore fluids from the argillaceous rocks of the Harwell region. (M A Brightman, A H Bath, M Cave & W G Darling)	June 1985
85-7	In situ radionuclide migration studies in a shallow sand aquifer. Part I (G M Williams, L S Alexander, S P Hitchman, P J Hooker, D J Noy, C A M Ross, A Stuart & J M West)	May 1985
85-8	The petrography of the Jurassic core from the Harwell Research Site. Part 2 .Kellaways Beds, Great Oolite Group and Inferior Oolite Group (A E Milodowski & I George).	Feb 1985
85-9	A study of natural and long-term (10^3 - 10^4yr) elemental migration in saturated clays and sediments. Part III. (P J Hooker, A B MacKenzie, R D Scott, I M Ridgway, I G McKinley & J M West)	May 1985

85-10	In situ radionuclide migration studies in a shallow sand aquifer. Part II appendices (G M Williams, L S Alexander, S P Hitchman, P J Hooker, D J Noy, C A M Ross, A Stuart and J M West)	May 1985
85-11	Long term effects on potential repository sites: climatic and geomorphological changes (M B Seddon and P Worsley)	May 1985
85-12	Long term effects on potential repository sites: occurrence and diagenesis of anhydrite (A H Bath, I George & A E Milodowski)	Sept 1985
85-13	Long-term effects on potential repository sites: the alteration of the Lower Oxford Clay during weathering (A E Milodowski, A J Bloodworth and R D Wilmot)	Sept 1985
85-14	Tolerances of micro-organisms to extreme environmental conditions (J M West & S C Arme)	March 1985
85-15	Reactivity of ordinary Portland cement (OPC) grout and various lithologies from the Harwell Research Site (A E Milodowski, I George, A J Bloodworth & N S Robins)	Aug 1985

FLPU REPORT SERIES - 1986

86-1	The assessment of borehole cement sealing characteristics by acoustic waveform analysis. (N R Brereton & M A Brightman)	Jan 1986
86-2	Deep source gases and hydrocarbons in the UK crust. (A H Bath, S C Brassell, G Eglinton, R I Hill, P J Hooker, R K O'Nions, E R Oxburgh J Parnell, N Robinson & B Spiro)	Feb 1986
86-3	Groundwater modelling for fractured and porous media: HYDROCOIN Level 1 (D Noy)	Jan 1986
86-5	A single hole tracer test to determine longitudinal dispersion. (D J Noy & D C Holmes)	April 1986
86-6	Natural analogues of radionuclide migration (May 1985 - March 1986). (P J Hooker, A B MacKenzie, R D Scott, M Ivanovich,T K Ball, I R Basham & P D Roberts)	May 1986
86-7	The measurement of the vertical component of hydraulic conductivity in single cased and uncased boreholes. (J H Black, D J Noy and M A Brightman)	Nov 1986
86-8	The influence of sulphate reducing bacteria on ^{137}Cs sorption and their tolerance in nutrient depleted natural materials - a preliminary study. (J M West, M A W Abbott & E J Rowe)	March 1986
86-9	The role of faults in the hydrogeological environment. (J H Black, J Alexander, P D Jackson, G S Kimbell & R D Lake)	Sept 1986

86-10	Studies of the effects of sulphate reducing bacteria on mild carbon-steel relevant to radioactive waste disposal in the U.K. (J C Philp, N Christofi, K J Taylor & J M West)	March 1986
86-11	Solute transport processes in a saturated clay. (R J Charles, A J Cook & C A M Ross)	Sept 1986
86-12	Geotechnical characterisation of Boom Clay in relation to disposal of radioactive waste. (S T Horseman, M G Winter & D C Entwisle)	Feb 1986

FLPU REPORT SERIES - 1987

87-1	Parameters and properties relevant to flow across mudrocks - measurement and interpretation. (M A Brightman, J Alexander & T P Gostelow)	Jan. 1987
87-2	Trace element and microbiological studies of alkaline groundwaters in Oman, Arabian Gulf: a natural analogue for cement pore-waters.(A H Bath, N Christofi, C Neal, J Philp, M Cave, I McKinley & U Berner)	July 1987
87-3	Mudrock hydrogeology and hydrochemistry of a shallow sedimentary environment : the Middle Thames valley area. (J Alexander, M A Brightman & A E Milodowski)	Oct. 1987
87-4	^{137}Cs sorption onto Fullers Earth (Calcium Montmorillonite) - the influence of sulphate reducing bacteria. (J M West, D G Haigh, P J Hooker and A J Rowe)	Oct. 1987
87-5	Characterisation of humic material for inter-laboratory comparison. (D Peachey and G M Williams)	Oct. 1987
87-6	The detection of boundaries in leaky aquifers. (A J Cook)	Feb 1987

FP SERIES

Report no.		Title and authors
FP 87	8	Loscoe - geological evidence to the public inquiry into the gas explosion at Loscoe. (N Aitkenhead, G M Williams)

End of FP Series- superseded by Technical Report Series 'WE'. The WE Technical Report Series also supersedes the FLPU Report Series.

WE REPORT SERIES - 1988

88/12	Preliminary studies of cobalt complexation in groundwater (P Warwick , P Shaw, G M Williams and P J Hooker).	Dec 1988
88/15	Characterisation of micro-organisms in a sand aquifer contaminated with industrial waste (S P Hitchman and G M Williams).	July 1989
88/16	A sorption study of ^{85}Sr, ^{137}Cs and ^{227}Th onto glacial sand as part of an interlaboratory exercise (D G Haigh and P J Hooker)	
88/17	Design and installation of a borehole array for radiotracer experiments at Drigg (G P Wealthall, J R Hallam and G M Williams).	Dec 1988
88/20	The effect of organics on the sorption of cobalt by glacial sand in laboratory batch experiments (D Haigh, G M Williams, P J Hooker, C A M Ross, M A Allen and P Warwick)	July 1989
88/24	Characterisation of colloid samples from the Grimsel test site interlaboratory comparison BGS analyses (C A M Ross and A E Milodowski).	Dec 1988
88/25	The development of portable equipment to study physical and chemical phases in natural waters. (N Breward and P Peachey).	May 1989
88/26	Theoretical potential of radial injection tracer tests with 3-D pressure and solute monitoring (G M Williams, D Noy, P D Jackson and R Mackay))	Dec 1989

88/34	A desk study of surface diffusion and mass transport in clays (A J Cook)	April 1989
88/40	The influence of microbial activity on degradation of acetate and EDTA. (J M West).	Dec 1989
88/43	Geochemical modelling of the Broubster natural analogue site, Caithness, Scotland. (D Read)	Dec 1989
88/44	Computer simulation of granite-water interactions using EQ3NR/EQ6. (W E Falck and D Savage).	Dec 1989
88/48	Chemical speciation modelling studies on groundwaters in a shallow glacial aquifer Part 1: General parameters (W E Falck, G W Quinn, J Duffield and D R Williams)	Dec 1989
88/49	Modelling the interaction between natural organic matter and metal cations: a reveiw (W E Falck)	Feb 1989

WE REPORT SERIES - 1989

* Report in preparation
† Report at printers

89/7	Geological sequence at the Down Ampney fault research site. (A Horton, K Ambrose and B M Cox)	Dec 1989
89/8†	The geomicrobiology of the Drigg research site. (J M West, E J Rowe, G P Wealthall and M R Allen)	July 1988
89/9*	Analysis tracer tests using Cl, ^{131}I and ^{3}H in a confined glacial sand at Drigg. (M Sen and G M Williams.)	
89/11	Dispers - a Fortran program to solve the advection - dispersion equation with varying boundary conditions and inhomogeneous distribution of parameters. (W E Falck and A H Bath)	
89/12	Faulting in mudrock: the selection of potential sites (J Alexander)	Feb 1989
89/13 †	Uranium migration at the South Terras mine, Cornwall. (P J Hooker, M Ivanovich, A E Milodowski, T K Ball, A Dawes and D Read)	
89/16	The effect of organics on the sorption of strontium,caesium, iodine, neptunium, uranium and europium by glacial sand. (D Haigh, J W Higgo, G M Williams, P J Hooker, C A M Ross, W E Falck, M A Allen and P Warwick)	Dec 1989
89/20*	Aromatic degradation in contaminated sediment cores from the Villa Farm disposal site (C A M Ross, G M Wiliams, H S Dhillon and R K Dart)	

89/21†	Principles of a computer controlled multi-electrode resistivity system for automatic data acquisition. (P Jackson, P Meldrum and G M Williams)	
89/30*	Stable isotope ratios in Methane containing gases in the UK (S P Hitchman, W G Darling and G M Williams)	
89/32†	Reconnaissance geophysics to locate major faults in clay (P D Jackson, J R Hallam, M G Raines, M P Ramsbury, P G Greenwood and J P Busby)	Dec 1989
89/33†	The charaterisation of organics from the natural analogue site at Broubster, Caithness, Scotland. (B Smith, M Stuart, B Vickers and D Peachey)	May 1989
89/36	Chemical speciation modelling of groundwater in a shallow glacial sand aquifer Part II: radionuclide speciation and effect of organics (G W Quinn, J R Duffield, W E Falck and D R Williams)	Dec 1989
89/37†	The geological geochemical, topographical and hydrogeological characterisation of the Broubster natural analogue site, Caithness (T K Ball and A E Milodowski)	June 1989
89/40*	Sorption studies of uranium in sediment groundwater systems from the natural analogue sites of Needle's Eye and Broubster (J J W Higgo, W E Falck and P J Hooker)	
89/41*	The groundwater chemistry of the BGS in situ migration experiments (D G Haigh, G M Williams and J J W Higgo)	

89/44* Iodine speciation and diffusion in infinite couple experiments (J J W Higgo and P Warwick)

89/45* Isolation purification and characterisation of natural organics from a glacial sand aquifer (M E Stuart, A D Bradley, B Smith and D Peachey)

89/47* A downhole ranging gamma spectrometer system for radio-tracer tests (G M Williams, P D Roberts, G P Wealthall and P Mooney)

89/48† An evaluation of the resistivity anistropy of the clays at the Down Ampney Fault Research Site (M G Raines, P D Jackson,C J Evans, P Meldrum and M Rainsnury)

89/50* The uranium source-term mineralogy and geochemistry at the Broubster Natural Analogue site, Caithness (A E Milodowski, I R Basham, E K Hyslop and J M Pearce)

89/55 Hydrogeochemistry of the Needle's Eye site - first interpretation (R Doublet, Ph. Jamet and R Soubeyran)

89/56* The location of uranium in source rocks and sites of seecondary deposition at the natural analogue site, Dumfries and Galloway (I R Basham, A E Milodowski, E K Hyslop and J M Pearce)

89/57* Two modified versions of the speciation code PHREEQE for modelling macromolecule-proton/cation interaction (W E Falck)

89/63* Hydrothermal mineralogy in geothermal assessment: studies of Miravalles Field, Costa Rica and experimental simulations of hydrothermal alteration (A E Milodowski, D Savage, A H Bath, N J Fortey, P H A Nancarrow & T J Shepherd)

89/64† Modelling of the Needle's Eye natural analogue. (Ph. Jamet, P. Lachassagne, R. Doublet & E. Ledoux) Jan 1990

89/65 Development of an analytical method for the analysis of iodide and bromide ion concentrations in lacustrine sediment interstitial water. (A. B. Mackenzie, T. M. Shimmield, R. D. Scott & C. M. Houston)

Last revised March 1990.

ANNEXE 8

PUBLICATIONS DU FLUID PROCESSES RESEARCH GROUP SUR LE THÈME DES DÉCHETS

BRITISH GEOLOGICAL SURVEY

FLUID PROCESSES RESEARCH GROUP

LIST OF PUBLICATIONS RELATED TO LANDFILL

1974

GRAY D A, MATHER J D and HARRISON I B, 1974. Review of groundwater pollution from waste disposal sites in England and Wales, with provisional guidelines for future site selection. Quarterly Journal of Engineering Geology Vol 7 No 2, pp181 - 196.

1975

MATHER J D 1975. Landfill pollution research in the United Kingdom. Geol Soc America, Abstracts with programmes.7(6), 816.

MATHER J D 1975. Hydrological and hydrogeological assessment of landfill sites. Discussion of paper by R Aspinwall. Solid Wastes 65(8), pp 394 - 7.

1976

HARRISON I B 1976. Construction of investigatory boreholes on landfill sites. Surveyor, Vol.147, No 4385, pp 22-24.

1977

BLACK J H 1977. Polyurethane foam - a useful new borehole grout. J Hydrology. 32 pp 183-188.

BLACK J H, BOREHAM D, BROMLEY J, CAMPBELL, D J V, MATHER J D, & PARKER A 1977. Construction and instrumentation of lysimeters to study pollutant movement through unsaturated sand. Proc of the water Research Centre Conference Groundwater Quality measurement, Prediction and Protection, reading, Sept 1976 PP327-340.

MATHER J D 1977. Attenuation and control of landfill leachates. Conference paper79th annual conf Inst Solid waste Management. Discussed in Solid Wastes 67(8) pp 362 - 378.

MATHER J D 1977. Dilute and Disperse versus Concentrate and Contain - a hydrogeologists view of the landfill controversy. Nat Association of Waste Disposal Contractors News. Oct 1977 pp18-21.

MATHER J D, SMITH D B, GRAY D A, CLIPSHAM E W, 1977. Environmental tritium as an indicator of potential groundwater pollution from landfills. Proc of the water Research Centre Conference Groundwater Quality measurement, Prediction and Protection, reading, Sept 1976 PP312 - 326.

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BROMLEY J, CAMPBELL, D J V, HARRISON I B, PARKER A & WILLIAMS G M, 1977. A study of waste disposal at Haigh Quarry, South Yorkshire. Department of the Environment WLR Technical Note Series No 38, HMSO, 53 pp.

1978

MATHER J D & Day J BW, 1978. The movement of oils from landfills and its effect on water quality. Proc . IInternational Symposium . Groundwater Pollution by Oil Hydrocarbons. Prague, June 1978 pp 163 - 165. (Reprinted in Aquifer Contamination and Protection. Studies and Reports in Hydrology, No 30 pp 350-353, UNESCO, Paris 1980).

MATHER J D & PARKER A, 1978. The disposal of Industrial and Domestic waste to a landfill overlying lower Chalk. Rep. No. AERE-R 9097, HMSO London. 27 pp.

MATHER J D, 1978. Potential groundwater pollution problems with mining and metallurgical wastes. Contribution to discussion on Control and disposal of mining and metallurgical wastes". Trans. Inst. Min. Metal. (Section A Min. Industry), 87, A 215 -7.

MATHER J D 1978. Hydrogeological aspects of the landfill disposal of hazardous wastes. In :"Treatment and disposal of hazardous wastes". Conference transscript. Oyez International Communications Ltd. London pp 33 - 41.

1979

WILLIAMS G M. 1979 Aspects of landfill Research in Britain. Proceedings of the international conference "Elmia-Avfall 79", Sept 1979, Jonkoping, Sweden, pp 558 - 582.

1980

ROSS, C.A.M. 1980. Experimental assessment of pollutant migration in the unsaturated zone of the Lower Greensand. Qrt. Jnl. of Eng. Geol. London, 13, 177-187.

ROSS, C.A.M. & LONGWORTH, G, 1980. Mossbauer study of the attenuation of iron in an irrigated Greensand Lysimeter. Clays and Clay Minerals, 28, 43-49.

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WILLIAMS G M, 1980. Investigation of the Landfill at Eastfield Quarry, Fauldhouse, West Lothian, Scotland between 1977-79. Waste and landfill Research Technical Report No 68, HMSO.

WILLIAMS G M, 1980. A study of groundwater pollution around the landfill at Greenoakhill Sand Quarry, Glasgow. Department of the Environment WLR Technical Note Series , HMSO, 29 pp.

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CAMPBELL, D.J.V., BLACK, J.H., BOREHAM, D., RAINES, M.G., REES, J.F., PARKER, A. & ROSS, C.A.M. 1981 Uffington lysimeters - operation and results (part 2). Atomic Energy Research Establishment Report - R10263, HMSO London. 39pp.

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HARRISON I B, PARKER A and WILLIAMS G M, 1981 Investigation of the Landfill at Eastfield Quarry, Fauldhouse, West Lothian, Scotland. Report of the Institute of Geological Sciences No. 81/13.

PARKER A and WILLIAMS G M, 1981 Landfill site selection and operation for municipal and hazardous waste disposal. In "Developments in Environmental Control and Public Health 2". (Ed) A Porteous. Applied Science Publishers Barking Essex.

PARKER, A., CAMPBELL, D.J.V., BLACK, J.H., BOREHAM, D., BROMLEY, J., RAINES, M.G., REES, J.F., & ROSS, C.A.M. (1981). Uffington lysimeters - operation and results (part 1). Atomic Energy Research Establishment Report - R10262, HMSO London. 54pp.

REES, J.F., CAMPBELL, D.J.V., PARKER, A. KING, J.W., & ROSS, C.A.M. (1981). Uffington lysimeters - operation and results (part 4). Atomic Energy Research Establishment Report - R10265, HMSO London. 31pp.

ROSS, C.A.M., REES, J.F., & LEWIS, G.N.J. 1981. Uffington Lysimeters - operation and results (part 5). Atomic Energy Research Establishment Report - R10266, HMSO, London, 41pp

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1982

WILLIAMS G M, 1982. Studies of leachate attenuation in intergranular aquifers. Proceedings of the Leachate symposium held at the Atomic Energy Research Establishment Harwell, Oxfordshire, 19th May.

1983

BLACK, J.H & KIPP, K.L. Jr. 1983. Movement of tracers through dual porosity media - experiments and modelling in the Cretaceous Chalk. J. Hydrol. Vol. 62. pp. 287 - 312.

CAMPBELL, D.J.V., REES, J.F., PARKER, A. & ROSS, C.A.M. 1983. Attenuation of potential pollutants in landfill leachate by Lower Greensand. Waste Management and Research, 1, 31-52.

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1984

ALEXANDER. L.S., 1984 A case study of a landfill in a shallow limestone aquifer near Banbury, Oxfordshire. Report of the British Geological Survey FLPU 84-10.

HITCHMAN, S.P. 1984. Assessment of techniques and media in the enumeration of microorganisms from a landfill site. Rept. Brit. Geol. Surv. FLPU 84-13.

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WILLIAMS, G.M., ROSS, C.A.M., STUART, A., HITCHMAN, S.P. & ALEXANDER, L.S. 1984. Controls on contaminant migration at the Villa Farm lagoons. Quarterly Journal of Engineering Geology, London, 17, 39-55.

1985

LONGWORTH, G., TOWNSEND, M.G. & ROSS, C.A.M. 1985. Mossbauer spectra of several magnetic sheet-silicates in external magnetic field. Proceedings of the International Conference on Applications of the Mossbauer Effect, Leuven, Belgium, Sept. 1985 (4pp).

MACKAY, R., PORTER, J., WILLIAMS, G.M., ROSS, C.A.M. & NOY, D.J. 1985. Modelling Mass Transport in the Saturated Zone - A case study. Proceedings of the International Conference on Water Quality Modelling in the Inland Natural Environment.

NEWMAN, R. & ROSS C.A.M. 1985. Mineralogical and geochemical controls on heavy metal pollution in monolith lysimeters. Report of the British Geological Survey FLPU 85-5

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WILLIAMS, G.M. 1985. Preliminary assessment of the hydrogeology of the Elstow Storage depot, Bedfordshire. Report of the British Geological Survey FLPU 85-3.
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1986

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WILLIAMS G M (as member of the reporting committee) 1986. Landfilling Wastes. Department of the Environment waste management Paper No 26, HMSO London 205pp.

WILLIAMS G M, 1986. Hazardous Waste Management and Landfill Research in UK. In proceedings of a seminar on "Hazardous waste: production, control and disposal" Oct 28 - 30th, organised by ISMES, Bergamo, Italy.

WILLIAMS G M, 1986. Investigating leachate migration from landfills. In proceedings of a seminar on "Hazardous waste: production, control and disposal" Oct 28 - 30th, organised by ISMES, Bergamo, Italy.

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CHAPMAN N A and WILLIAMS G M 1986. Hazardous and radioactive waste management: a case for dual standards? In proceedings of the 22nd conference of the Engineering group of the Geological Society.

1987

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ROBINS N S 1987. Waste Disposal: In search of new landfill sites in Scotland. Modern Geology Vol 11 pp 251 - 254.

WILLIAMS G M and MATHER J D 1987. Difficult wastes in landfills. Waste Management Bulletin No 14 (April, 1987), Department of the Environment, HMSO, London.

WILLIAMS G M, 1987. Integrated studies into the disposal of hazardous wastes. Conference on the Land disposal of hazardous wastes, University of Cambridge, England 9th -11th September 1987.

CHAPMAN N A & WILLIAMS G M. 1987. Hazardous and radioactive waste management: a case for dual standards? Conference on the Land disposal of hazardous wastes, University of Cambridge, England 9th -11th September 1987.

LAMB H M, 1987. An investigation of anaerobic methane oxidation in polluted groundwater at the Villa Farm disposal site. MSc research report, University of Leeds.

MACKAY R and COOPER T A 1987. Modelling of contaminant migration at Villa Farm Lagoons. Final report. NERC Water Resource Systems Research Unit Dept of Civil Engineering, University of Newcastle upon Tyne.

1988

DHILLON H S, 1988. Microbial degradation in soil and groundwater. Unpublished PhD thesis, Loughborough University of Technology. 179 pp.

HITCHMAN S P, 1988. A collection manifold for multilevel groundwater sampling devices. Ground Water, vol 26, no 3, pp 348 - 349.

HITCHMAN S P & WILLIAMS G M, 1988. Identification of micro-organisms in a shallow sand aquifer contaminated by industrial wastes. Report of the British Geological Survey Fluid Processes Research Group, WE/88/15.

MILLAR S K, 1988. Method development and investigation of sulphate reducing bacteria in a shallow sand aquifer contaminated with industrial waste. MSc research report, Napier College, Edinburgh.

HITCHMAN S P and COOK A J, 1988. Transport of phenol and chloride in a shallow sand aquifer. Report of the British Geological Survey Fluid Processes Research Group, in prep.

WILLIAMS G M, NOY DJ, JACKSON PD & MACKAY R 1988. Theoretical potential of radial injection tracer tests with 3-D solute and pressure monitoring. Report of the British Geological Survey Fluid Processes Research Group, WE/88/26.

1989

DHILLON H S, ROSS C A M, WILLIAMS G M, DART R K, 1989. Aromatic degradation in contaminated cores from the Villa Farm disposal site. Report of the British Geological Survey, Fluid Processes Research Group, WE/89/20.

JACKSON P D, MELDRUM P, WILLIAMS G M, 1989. Principles of a computer controlled multi-electrode resistivity system for automatic data aquisition. Report of the British Geological Survey Fluid Processes Research Group, WE/89/21.

WILLIAMS G M & AITKENHEAD N, 1989 A case study - the gas explosion at Loscoe Derbyshire. Conference entitled "Methane Facing the problems" Nottingham University, 26-28 th September.

WILLIAMS G M & HITCHMAN S P, 1989 The generation and migration of gases in the subsurface. Conference entitled "Methane Facing the problems" Nottingham University, 26-28 th September.

HITCHMAN S P, DARLING W G, WILLIAMS G M, 1989. Stable isotope ratios of carbon and hydrogen in methane containing gases in the UK. Report of the British Geological Survey, Fluid Processes Research Group, WE/89/30.

MATHER J D 1989. The attenuation of the organic component of landfill leachate in the unsaturated zone : a review. Quarterly Journal of Engineering Geology, London, Vol 22 pp 241 - 246.

1990

WARD R S, WEALTHALL G P, WILLIAMS G M, JACKSON P D, MELDRUM P, 1990. Evaluation and calibration of a computer controlled multi-electrode resistivity system. Report of the British Geological Survey, Fluid Processes Research Group, WE/90/01.

WILLIAMS G M, 1990. The migration and leachate and gas from landfills'. Proceedings of a conference, "Landfill Problems and Solutions". Brunel University, 15 - 18th May 1990.

IN PREPARATION

WARD R S, WEALTHALL G P, 1990. Design and installation of an array for radial injection tracer tests in a layered anisotropic fluvial sand aquifer. Report of the British Geological Survey, Fluid Processes Research Group, WE/90/21.

HITCHMAN S P, DARLING W G, WILLIAMS G M, WARD R S, 1990. Investigation of anaerobic methane oxidation in a sand aquifer contaiminated by industrial wastes. Report of the British Geological Survey, Fluid Processes Research Group, WE/90/22.

SUBMITTED FOR PUBLICATION

WILLIAMS G M & AITKENHEAD N. Lessons from Loscoe: the uncontrolled migration of landfill gas. Paper submitted to the Quarterly Journal of Engineering Geology.

ANNEXE 9

PERSONNEL DU NIGL, DONT PERSONNEL BAS ET BGS DÉTACHÉ

Source : NERC isotope Geosciences Laboratory 1987-1990 Report p. 29

NIGL

Carolyn A Chenery
BSc (Hons., London, 1977)
MS (Boston University, 1981)
Trace and rare earth element geochemistry of basic and ultrabasic layered and ring intrusions; mineral melt geochemical relationships; fluid inclusion geochemistry of quartz associated with gold deposition.

D P Fiona Darbyshire
BSc (Edinburgh 1967)
Origin and evolution of granite magmas and related mineralisation; radiogenic isotope studies of fluid inclusions; evolution of the basement in NE Africa.

Jane A Evans
BSc (Hons., London 1978)
MSc (Oxon 1980)
PhD (London 1990)
Behaviour of isotope systems during low-grade metamorphism; isotopic evolution of the Welsh basin.

Peter Greenwood
BSc (Hons., Cantab 1965)
Stable isotope mass spectrometry and analytical techniques; igneous petrology.

Russell S Harmon
BA (Hons., University of Texas at Austin, 1969);
MS (The Pennsylvania State University, 1972);
PhD (McMaster University, 1975)
Stable isotope systematics of igneous rocks; hydrothermal mineralisation; U-series geochronology; Pleistocene paleoclimatology; volcanology.

Tim H E. Heaton
BSc (Hons., Leeds 1972),
PhD (Edinburgh 1976)
Stable isotope geochemistry; nitrogen cycles in the atmosphere and biosphere; groundwater hydrology; Quaternary geology, archaeology.

Pamela D Kempton
BSc (Summa Cum Laude, James Madison University, 1977)
MS (Southern Methodist University, 1980)
PhD (Southern Methodist University, 1984)
Petrology and geochemistry of ultramafic peridotites; lower crustal granulites; continental alkalic basalts, oceanic basalts and gabbros.

Steven Noble
BS (Toronto 1980)
MS (Toronto 1983)
PhD (Toronto 1989)
U-Pb geochronology and radiogenic isotope tracer geochemistry.

Chris C Rundle
BSc (Hons., London External, 1968)
PhD (London External, 1982)
General geochronology, with particular emphasis on the K-Ar and Rb-Sr systems and instrumental methods for isotopic ratio measurements.

Baruch Spiro
BSc (Hebrew University, Israel, 1968)
MSc (Hebrew University, Israel, 1970)
PhD (Hebrew University, Israel, 1979)
Stable isotope fractionation processes, low temperature isotope, inorganic and organic geochemistry; water rock reactions and mineralisation processes; development of laser based isotope techniques.

Ian G Swainbank
MA (Cantab, 1954)
PhD (Columbia University.NYC, 1967)
Common lead mainly in the study of ore deposits; U-Pb dating of accessory minerals; general geochronology.

Adrian J Boyce (based at SURRC)
BSc (Hons., Glasgow, 1980)
PhD (University of Glasgow, 1989)
Isotope geochemistry of ore deposits; isotope geochemistry in granite petrogenesis; sulphide and sulphate diagenesis; studies in Bulgarian geology.

BAS

Robert J Pankhurst
BA (Hons., Cantab.,1964)
MA (Cantab.,1967)
Diploma in Geochemistry (Oxon., 1965)
DPhil (Oxon, 1968)
Polar Medal (1987)
Radiogenic isotope analysis and application to the age and petrogenesis of igneous and metamorphic rocks; Gondwana magmatism and the formation of the Andean Cordillera; scientific editing.

Ian L Millar
BSc (Hons., Glasgow, 1980)
Application of radiogenic isotope techniques to problems of Antarctic geology; pre-Caledonian history of the Moine assemblage of NW Scotland; the use of computer in handling isotope data.

BGS

Thomas J Shepherd
BSc (Hons., Durham 1965)
PhD (Durham 1973)
MIMM
Visiting Prof Imperial College (1989-).
Economic geology; geochemistry of crustal fluids; application of fluid inclusion studies to low grade metamorphic and sedimentological problems; laser beam analytical chemistry.

Martin F Miller
BSc (Hons., Bristol, 1975)
Light element stable isotope systematics of crust/mantle fluid volatiles and associated experimental techniques.

Jon Naden
BSc (Hons., London, 1982)
PhD (Aston, 1988)
Mineral and fluid chemistry of gold and base metal ore deposits; application of fluid inclusions in basin analysis and low-grade metamorphism; numerical analysis and computer simulation of geological problems.

ANNEXE 10

ACTIVITÉS DU BGS A L'ETRANGER 1 APRIL 1990

SUMMARY OF CURRENT AND PLANNED BGS ACTIVITIES OVERSEAS

A ASIA

1. BANGLADESH

1.1 TC Programmes*

Barapukuria Coal Project. BGS continued to monitor on ODA behalf progress of the ODA-appointed Consultants in implementing Stage II of this exploration project. A further site visit took place in January (M C G Clarke) to review drilling progress and advise on training programmes for associated Bangladeshi staff. Rigs had been operational for approximately one month at the time of the visit. The ODA Consultants agreed to provide additional geological staff to back-up the drilling. A further visit is scheduled for April.

2. BURMA

2.1 R & D Programme

The collector well programme in Burma is in abeyance while UK government aid remains suspended (R Herbert).

3. CHINA

3.1 TC Programmes

Tibet Salt Project. A revised proposal submitted by the Chinese for assistance with salt exploration and evaluation in Tibet was assessed at ODA request. An appraisal visit will be required before any commitment by ODA. (NB. This assessment pre-dated the problems in PRC, and the proposal is presumed on hold, pending resumption of normal relationships).

3.2 Science Budget and Royal Society

Jiangxi Granite Metallogeny. The current phase of the BGS-Ministry of Geology collaboration is extended to December 1990 when final reports and atlases, integrating geological, geophysical and remotely sensed data, are due for submission and subsequent publication by the Chinese authorities. The final field visit took place during this period (P R Simpson, P Stone). A Chinese co-worker continues to assist in writing up project results in UK. He is currently extended to June 1990. The Chinese have requested further BGS support. Funding will be required to permit this.

3.3 R & D Programme

Saline Intrusion Modelling. See Regional Activities. (Item 12.2)

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* All TC and R & D programmes and OSAS secondments funded by ODA unless otherwise stated.

3.4 Groundwater Modelling, Beijing

Following visits to China by J B W Day, H Fish, J Mather and J McCulloch, BGS and IH have been invited to bid for a groundwater modelling and data collection exercise for the Beijing region. This project was approved by ODA - verbally - and then put in abeyance after the disturbances there.

4. HONG KONG

4.1 BGS consultancy

BGS (NERC) has an open-ended Consultancy agreement (CE 29/82) with the Hong Kong Government Geotechnical Control Office (GCO), to assist the geological survey of the Territory and its offshore areas. BGS supplies three geologists on long-term leave of absence to staff the Geological Survey Section of GCO (P J Strange, R L Langford, J W C James). Replacements for these officers have been requested on expiry of their current contracts during 1991. Under the same agreement, services continued to be provided in marine geology/offshore resource assessment (C D R Evans) and reporting was completed on geochronological and hydrogeological support to CE 29/82 and to the separate agreement CE 33/87. Under the latter, BGS continued to coordinate the detailed subsurface study of karstic limestones in an area of intensive urban development in the northwestern New Territories (D V Frost). This programme is due for completion in April 1990. BGS Regional Geologist Asia (Acting - J D Bennett) undertook a liaison visit to GCO in November 1989.

5. INDIA

5.1 TC Programmes

Assam Arunachal Pradesh and Krishna Godavari Basin Projects. BGS continued to monitor consultant's work on ODA behalf (A Whittaker).

Ghusick Coal Project. ODA requested BGS to assess available data following the report of higher than anticipated incidence of minor intrusions in the coalfields and prior to providing the significant additional development funding sought by ODA consultants to enable them to reassess the feasibility of establishing an underground longwall mining operation (M C G Clarke). Review of data was completed.

Cooperation with World Bank on **West Bengal and Punjab Minor Irrigation Projects.** A visit was made to two World Bank-funded projects in India. Collector Wells, developed in an ODA/BGS R & D Programme would be useful in both projects. Recommendations have been made to the World Bank suggesting a Pilot Development Project should be funded so as to demonstrate the value of such wells in the field.

5.2 R & D Programmes

Agrogeology. See Regional Activities. (Item 12.2).

Groundwater Pollution Studies. Plans have been made to collaborate with the Centre for Water Resources of Anna University, Madras and the Frederick Institute of Plant Protection and Toxicology (FIPPAT) on joint research on the effects of intensive agricultural practices on groundwater quality. A R Lawrence has made visits to Madras and members of staff from Anna

University have visited BGS, Wallingford. Delays in formalising arrangements for the transfer of funds to FIPPAT for local costs, principally drilling and pesticide analysis, mean that the observation boreholes have not been constructed to enable monitoring to start before the 1988 monsoon season. Subsequently further delays have resulted from changes in personnel at both FIPPAT and Anna University. A R Lawrence visited Madras in November 1989 and again in March 1990. Drilling of observation boreholes finally commenced from August 1989 (P J Chilton and A R Lawrence).

6. INDONESIA

6.1 TC Programmes

Southern Sumatra Geological and Mineral Exploration Project (SSGMEP). A 4-year project commenced October 1988, staffed by a 4-man BGS team (Team Leader/Economic Geologist - M J Crow, Geochemist - C C Johnson, Geologist/Editor - M J Holder, Geophysicist - A Walker). The project is being carried out in collaboration with Directorate of Mineral Resource (DMR) and the Geological Research and Development Centre (GRDC), Bandung. Progress continued to be made during the period in bringing together the two independent Directorates and coordinating their activities in Southern Sumatra, in supervising DMR geochemical exploration and assisting the acquisition of exploration data, in acquiring and assessing regional gravity data, with complementary fieldwork, and in the preparation of 1:1 000 000 scale geological maps. Priorities were drawn and procedures and scheduling developed for the systematic editing of 1:250 000 scale maps and reports and remote sensing data were procured to permit upgrading of existing maps and to facilitate regional structural interpretation and geological/stratigraphical correlations. SSGMEP was visited by Regional Geologist Asia in November (Acting - J D Bennett).

Indonesian Hydrocarbon Basin Assessment Programme (IHBAP). Phase II of the 4-year (1985-1989) joint programme between LEMIGAS, BGS and London University was completed in October. Phase III commenced in November. BGS manages and coordinates the programme for ODA (Project Coordinator - A MacFarlane). Project Coordinator and Project Geologist/Geophysicist (G Kirby) continued at post. Short term inputs by BGS Consultant Core Analyst (A Butcher) and Technical Editor (J P Berrange) were completed during the period. Recruitment of staff to fill vacancies in the areas of Basin Analysis (3), Reservoir Engineering (5), and Technical Editor(1), was actively pursued and the posts will be taken up on a residential basis during the coming period. The Phase III training programme was initiated (Reservoir Description and Rock Mechanies, external tutors). Monitoring visits were undertaken in November by BGS Regional Geologist (Acting/LEMIGAS Project Manager - J D Bennett) and ODA/EAD Special Adviser (P Walmsley). Discussions were held with ODA to develop a satisfactory Field Management agreement for the project as precursor to a formal umbrella agreement for all future ODA-BGS TC work. The Field Management agreement was at an advanced stage by the end of the period.

ODNRI Land Resources Overview. ONDRI requested BGS input to an overview report on land use in Indonesia, summarising the results of a major study funded by World Bank and ODA (UK team). Geological/lithological and mineral/energy resource maps at 1:2 500 000 scale and a short linking explanatory text were finalised and submitted to ODNRI (M C G Clarke). Final checking was undertaken in Indonesia.

Lake Toba Project. A proposal, led by IH and involving BGS, to investigate environmental and other problems connected with the fall in surface level of Lake Toba, Sumatra, which is affecting the Asahan hydroelectric scheme and the Inalum aluminium smelter, was accepted by GOI. ODA support was agreed for the initial phase, leading to a symposium to be organised by GOI (BPPT) early in the coming period. BGS undertook preparation of a regional geological overview for presentation at the symposium (B G N Page, D T Aldiss).

6.2 R & D Programmes

Engineering geology of Tropical Red Clays Soils Project. (See Item 12.2)

6.3

BPPT Marine Survey. Discussions were held with BPPT, Jakarta following their request for BGS assistance in planning and implementing a major offshore geological survey and mapping programme, for which ADB funding is believed to be forthcoming. An initial desk study was recommended and ODA funding requested, but at the end of the period no formal request had been received from BPPT by ODA.

6.4 Advisory

The Mining Adviser participated in a project evaluation mission to Ombilin Coal Mine in Sumatra. The mine was mechanised with British equipment supplied under ATP, with additional support for training and operational assistance. The opportunity to review the continuing role of ODA in the project was taken.

7. LAOS

7.1 Commissioned Research

National Mineral Exploration Programme. BGS was shortlisted by Asian Development Bank (ADB) at the end of the period to tender for the opportunity of undertaking the development of the programme. BGS indicated intention to submit a proposal.

8. MALAYSIA

8.1 TC Programmes

Geological Survey of Malaysia (GSM) - Geophysics. At a seminar held at BGS in November a former BGS geophysicist (A J Burley) presented the results of his assignment, during which he assisted GSM in the interpretation and follow-up of an aeromagnetic survey of the Central Belt, Peninsular Malaysia, and planned and helped implement a national gravity survey of the Malaysian Peninsula.

GSM - Technical Editor. BGS Technical Editor (B D Hackman) continued his supervision of GSM's Publication Unit and completed his review of the future publication policy of the Survey before leaving in March. Assistance in commissioning and maximising the use of Desk Top Publishing equipment, donated by ODA, (DTP) was rendered in Ipoh (R C Jones) and training in DTP given to a GSM staff member at BGS during the second quarter.

Further mainly short-term support to GSM, agreed by ODA through c. mid-1991, covers the areas of gold exploration, geophysical computing and the establishment of a mineral commodities unit. Further minor input to the computing and DTP activities of the commodities unit took place in December R C Jones). Short term input to the gold exploration programme of GSM commenced February 1990 (R D Walshaw). This programme will subsequently involve the provision of 1 residential TCO.

8.3 R & D Programmes

The Southeast Asia Tin Granite Project. (See Item 12.2)

9. PAKISTAN

9.1 TC Programmes

Minerals Testing Laboratory, Sarhad Development Agency (SDA). Monitoring continues; comment on progress reports was provided during the period (J D Bennett). A SDA request for further BGS assistance with its mineral exploration programme (input by R C Leake) was reviewed and considered desirable, but not strictly within TORs of the MTL project. ODA gave the request favourable consideration but were unable in the final analysis to commit funds.

9.2 R & D Programme

Saline Intrusion Modelling. See Regional Activities. (Item 12.2).

9.3 Commissioned Research

National Mineral Exploration Programme (NMEP). BGS was shortlisted by the Asian Development Bank (ADB) to undertake the development of a 10-year national mineral exploration programme for and in collaboration with the Geological Survey of Pakistan (GSP). BGS advised verbally that the proposal submitted in September 1989 was unsuccessful but no formal advice of this, or of the identity of the successful organisation was received during the period.

10. SRI LANKA

10.1 R & D Programmes

Groundwater Pollution Studies. A visit was made to Sri Lanka in October 1986 to review groundwater pollution problems caused by low cost sanitation and by the intensive use of fertilisers and pesticides in irrigated agriculture. Reports on each of these were prepared, and in the latter case proposals for collaborative research on the impact of agricultural practices on groundwater were made. A field area was selected, the Kalpitiya Peninsula in the NW Dry Zone and a detailed programme of drilling, sampling and monitoring prepared. The work is being carried out in collaboration with the Water Resources Board, the Agriculture Department and the Kalpitiya Agricultural Research Station. A R Lawrence visited Sri Lanka in October/November 1987 to initiate the field work by establishing a network of monitoring wells, and selecting sites for drilling. A second visit was made in February/March 1988 at the time of commencement of the construction of the observation boreholes and the installation of lysimeters. Monitoring of water quality in these observation

wells commenced prior to the 1988 monsoon season and is continuing. A R Lawrence visited in November 1989, and in March 1990. The project is planned for completion in March 1991 (P J Chilton and A R Lawrence).

11. THAILAND

11.1 R & D Programme

The Southeast Asia Tin Granite Project. See Malaysia. (Item 8.3).

12. REGIONAL ACTIVITIES

12.1 ESCAP and Intergovernmental Committees

Committee for Coordination of Joint Prospecting of Mineral Resources in Asian Offshore Areas (CCOP)

UK provides a Special Adviser to annual sessions (A J Reedman) and supplies occasional experts to run training courses and seminars and to undertake special assignments. Provision of Special Adviser is projectised in BGS Subvention, supply of other experts funded from Regional TC. The XXVI Session took place in Bangkok in November (C R Jones).

Committee on Natural Resources (CNR)

UK sends a delegate to biennial annual meetings (as from April 1988), projectised in BGS Subvention. XV session was held in Bangkok, October 1989 (C R Jones).

12.2 R & D Programmes

Agrogeology. The low cost agromineral resources for developing countries project (J D Appleton) seeks to investigate such resources in various developing countries to see whether the direct applications of crushed rocks can improve soil fertility without having to resort to the capital and energy intensive processes involved in the production of chemical fertilisers. During the second half of the first year of the project a visit was made to India to examine existing usage of direct application fertilisers and the feasibility study phase of the project completion next period, was continued.

Engineering Geology of Tropical Red Clay Soils Project. ODA agreed the extension of the project through 1990/91. Phase I-II reports are scheduled for completion during the coming period. Limited amounts of laboratory testing were carried out (mainly on Kenyan material) and a further field visit to Indonesia is scheduled for May 1990 (P Hobbs). Clearances have been requested. The aim during the visit will be to undertake similar deep profile sampling and possibly the evaluation of drilling techniques to permit collection of undisturbed samples in Indonesia early 1990/91.

Mineral Resources Development in the Third World. A visit was made to Malaysia, Indonesia, Philippines and Thailand to follow-up work carried out to date, assess further requirements, and make arrangement for a forthcoming CEC-funded industrial minerals training course to be held in Ipoh, Malaysia in May (D Morgan).

Thermal History of Petroliferous Basins in Eastern Asia. A further visit to the CCOP/WGRA series of meetings was undertaken in connection with this project in March-April, 1990. Results to date were presented (D Holliday, A Chadwick, J Rowley). The project was also represented at the CCOP/CNR meeting last autumn.

Seabed Gamma-Ray Spectrometer. Results of the cruise/demonstration in Philippines waters last summer were worked up, assisted by the presence at BGS of a Filipino counterpart. Equipment design modifications were developed (D G Jones, P D Roberts).

Saline Intrusion Modelling. A field experiment in UK has been carried out to gain experience in sampling techniques and assessment of dispersion parameters. Preliminary results indicate that dispersivity is scale dependent and that such dependence will need to be incorporated in models of saline intrusion systems. The aim now is to obtain good datasets from a number of overseas locations so that models can be developed to simulate saline intrusion on a larger scale. Drilling and sampling will be undertaken where appropriate to supplement existing data. Sources of datasets being investigated at present are Pakistan, Mexico and India.

The Southeast Asia Tin Granite Project. Documentation was completed in collaboration with the geological surveys of Malaysia, Thailand and Indonesia. Overseas Memoir copy was submitted for publication and final corrections are in progress. Remaining were reports placed on open-file in early 1989 E J Cobbing).

12.3 EEC Funding

An EEC-sponsored training course is approved for May 1990 (D Morgan, Course Leader), venue Ipoh, Malaysia (see item 12.2). The 25 participants are to be drawn from Indonesia, Malaysia, Philippines, Thailand. The course title is 'Evaluation of Clays and Ceramic Raw Materials'. EEC member states will provide additional course tutors.

B PACIFIC

1. FIJI

1.1 TC Programme

Groundwater Resource Assessment and Development Unit (GRADU). A 3 year project involving two TCOs designed to strengthen the Mineral Resources Department's (MRD) capacity for groundwater resource assessment and development and to make a preliminary assessment of resources and produce hydrogrological maps. Initial phase completed with the preparation of 2 hydrogeological maps and final report; the first of these maps has now been published in Fiji. The second hydrogeological map is being produced in the UK, with ODA funding, as MRD has lost the majority of its drawing office staff and is unable to complete the work. One TCO (S K Booth) remained attached to GRADU to end 1989 while counterpart (P Kumar) completed MSc training at Birmingham University. S K Booth spent two weeks at BGS Wallingford in February in order to complete the final report.

1.2 OSAS Secondments

Senior Hydrogeologist supplied to head Hydrogeology Section in Mineral Resources Department (J Davies). Involved initially in Sigatoka Valley Rural Development Scheme which aims to improve agricultural output by irrigation using both groundwater and surface water. With the departure of S K Booth from GRADU at the end of 1989, J Davies will head GRADU and be responsible for all groundwater work in Fiji. This post should be filled by a seconded officer until at least 1992.

1.3 R & D Projects (Subvention)

Ammonium geochemistry in the search for hydrothermal gold mineralisation. This project, started in May 1986, aims to investigate whether ammonium alteration is associated with gold mineralisation in the circumoceanic environment and, if so, to establish its nature and the practicality of using such alteration in exploration. Studies have been conducted in Fiji, Solomon Islands and Vanuatu with the cooperation of the government geological organisations of those countries. Although results from the western cordilleras of the Americas have demonstrated the clear potential of ammonium geochemistry as an exploration tool for precious metal vein deposits, the data for the southwest Pacific region are more equivocal and further work on deposits of known geometry is needed. The work to date has been reported in a paper published in the journal Applied Geochemistry.

1.4 Commissioned Research (not subvention)

The Petroleum Geologist (H Johnson) provided to the Technical Secretariat of the South Pacific Applied Geoscience Commission (SOPAC) through secondment to CFTC terminates his appointment in 31 August 1990.

2. SOLOMON ISLANDS

2.1 OSAS Secondments

The post of Director of the Geological Survey Division, Ministry of Natural Resources, has remained vacant since Dr R D Walshaw completed his tour in the post in June 1989. A request to fill the post is awaited from the Solomon Islands Government.

Senior Geologist (Mapping)/Geochemist - M P Hawkins completes his 2 year tour in April 1990 and his appointment is to be extended by a further year.

Senior Geologist (Mapping) - M Barron completes his two-year tour in October 1990. It is understood that the Solomon Island Government will require a further appointment to this post.

2.2 R & D Project

Ammonium geochemistry in the search for hydrothermal gold mineralisation. See Item 1.3.

3. TONGA

3.1 OSAS Secondment

A Marine Geologist (R Gatliff) is supplied as Government Geologist to the Tonga Government. It has been recommended that this position be localised at the end of R Gatliff's current two-year tour in April 1990 and that a 3 month extension is arranged to assist in the localisation process.

3.2 TC Programmes

A proposal by BGS for a six month coastal mapping, resource inventory, and establishment of the geological database is currently under study by BDDP and the Tongan Government.

4. VANUATU

4.1 OSAS Secondment

The position of Director of Geology, Mines and Rural Water Supply was filled in November 1989 (Dr C Mortimer).

The current Applied Geologist/Hydrogeologist (C Cheney) completes his 2 year tour in June 1990.

Mr M Abbot is being nominated to ODA for a 2 year tour to replace Mr Cheney.

4.2 R & D Project

Ammonium geochemistry in the search for hydrothermal gold mineralisation. See under Fiji.

5. REGIONAL ACTIVITIES

5.1 Committee for Coordination of Joint Prospecting for Mineral Resources in South Pacific Offshore Areas (CCOP/SOPAC)

UK provides a Technical Adviser to annual sessions (B G N Page) and supplies experts to run training courses and seminars; provision of Adviser is projectised in ODA/BGS Subvention. 16th Session held in Canberra, Australia, September/October 1989.

C LATIN AMERICA AND CARIBBEAN

1. BOLIVIA

1.1 TC Programmes

Proyecto Precambrico (1975-86). Follow-up was undertaken to publicise the results of the seminar-workshop on the mineral potential of the Bolivian Precambrian Shield. A British company has subsequently shown interest. Work continued on the 1:1M minerals map which is now at an advanced stage, and the framework for the supporting text was developed (E O'Connor).

2. COLOMBIA

2.1 TC Programmes

Cali Geological and Training Project. In progress 1986-1990. Designed to assist the Cali Regional Office of INGEOMINAS with its mineral exploration programme, mainly for placer gold in terraces along the Pacific littoral by providing planning and operational support and short term expertise in various aspects of modern mineral exploration as a basis for training Colombian field geologists. Routine fieldwork in the Guapi basin was completed during the period. Regional Geologist Latin America (Acting - J D Bennett) visited the project in March to discuss progress and final reporting arrangements. INGEOMINAS requested an extension to the project during the visit. Short term specialist input and training in electron probe microscopy techniques, including work on project material, was undertaken in Bogota during March (B Beddoe-Stephens).

3.1 TC Programmes

PACOMI. This 3-year project, which commenced in November 1987 to assess the Industrial Mineral Potential of Costa Rica continued. The Phase I study, to prepare a national industrial minerals inventory, was completed. Team Leader during this phase (J P Berrange) completed his contract in December. Phase II, the examination of selected mineral commodities, was initiated during the second half of the period (S J Mathers). UK laboratory work was undertaken by BGS on behalf of the project.

3.2 R & D Programme

Mineral Resource Development in the Third World. R & D work was undertaken on material supplied by PACOMI.

4. ECUADOR

4.1 TC Programmes

Cordillera Real Project. In progress (1986-90). Investigation of geology, structure, evolution and metallogeny of Cordillera Real and preliminary examination of mineralised areas, particularly those where gold occurs (M Litherland - Team Leader, J A Aspden). Systematic traverses were completed and preparation of final maps and reports commenced. ODA approved a 2-year

extension to the project to permit mineral-orientated follow-up studies in the Cordillera Real geological and mineral investigation of the El Oro province and preparation of national geological and metallogenic-tectonic maps. A new agreement was prepared and submitted to the Ecuadorian Government for consideration. Short term specialist input and training in petrographic techniques was provided in Quito during the latter part of the period N Fortey). Final items of equipment to ensure the continued effective operation of the Quito Polytechnic XRF facility were handed over.

5. HONDURAS

5.1 TC Programmes

SANAA/ODA. The management of groundwater activities within SANAA has been revised following a supervisory visit by B L Morris. A hydrogeology coordination office has been established to which both resident TC hydrogeologists work (R Marks, A McKenzie). At the same time an overhaul by SANAA of its drilling arrangements together with a policy to contract out future production well work should result in improvements in the unit's ability to coordinate all groundwater investigation and development activities carried out by SANAA. During the period under review, an active programme of site visits and studies has been conducted on behalf of various divisions concerned with both rural and provincial town water supply. A proposal to extend hydrogeologial assistance to 1992 was submitted for TC funding.

5.2 R & D Programme

Hydrogeological Workshop. The response to circulation of the preliminary programme both internationally and within Honduras has been very encouraging. Invitations have been issued to representatives from Costa Rica, Panama, Guatemala, Nicaragua and Colombia, and suitable candidates in Honduras have been identified. Two important components of this practically-oriented workshop are in progress; the groundwater chemistry manual and oral presentations have been written in part and translation commenced, while 1½ days of field excursions have been worked out in detail (B L Morris, Tech. Sec., D G Kinniburgh, W M Edmunds, J M Cook (BGS), B Lloyd (Robens Institute)).

6. MEXICO

6.1 R & D Programmes

Ammonium Geochemistry Project. Processing and evaluation of Mexican data, to assess the application of ammonium minerals to hydrothermal gold exploration continues. Results to date were presented in October at the 13th International Geochemical Exploration Symposium, Rio de Janiero (J Ridgway).

Groundwater Pollution Studies. A collaborative programme has been established with the Sonora Institute of Technology (ITSON) to study the impact of irrigated agriculture on groundwater quality. Problems are associated with rising salinity, and possible leaching of pesticides and nitrate fertilisers. After preparatory visits, fieldwork began in February 1988 with the drilling of two cored observation boreholes. The main collaborating hydrogeologist from ITSON was at BGS Wallingford on a British Council study visit in September 1988. A second phase of drilling of observation boreholes is planned for early 1989 but has been delayed by reorganisation of the water

agencies in Mexico. Visits were made by P J Chilton in July 1989 and February 1990 to discuss local funding for the second phase of drilling, which is now planned to commence in April 1990. L R Bridge will visit Mexico at this time.

Impact of Urbanisation on Groundwater. A second proposal for studies of urban pollution of the Yucatan limestone at Merida was re-submitted for TC Funding after visits by L R Bridge and P J Chilton to Mexico in early 1988, but TC funds are fully committed for the next two years. This study is now being considered for inclusion into a new R & D programme into the effects on groundwater caused by urbanisation (B Morris and A R Lawrence).

7. PERU

7.1 R & D Programmes

Processing of data deriving from the study of the spectral expression of alteration associated with hydrothermal mineralisation in the Peruvian Andes as part of the project **Application of High Resolution Satellite Data to Mineral and Geothermal Resource Exploration** was carried out. Final reporting nears completion (B J Amos, D Greenbaum).

8. VENEZUELA

8.1 Commissioned Research (not subvention)

A short exploratory visit was made in March by Regional Geologist Latin America (Acting - J D Bennett), to ascertain the possibility of opportunities for BGS in Venezuela and the region. Calls were paid on the Andean Development Corporation, Latin-American Development Bank and the Venezuelan Ministries of Mines and the Environment.

9. CARIBBEAN ISLANDS

9.1 TC Programme

Hydrogeological Mapping. UNESCO are coordinating the preparation of an hydrogeological atlas of the Caribbean and BGS, funded by ODA, are assisting in this study with the following islands: Turks and Caicos, Anguilla, St Kitts and Nevis, British Virgin Islands, Grenada and St Vincent and the Grenadines. Fieldwork was completed during June 1988 and manuscript copies of the maps and accompanying notes were submitted to UNESCO at a Workshop in Caraca during September. The final report was map photos has been given to UNESCO.

Discussions have been held with the Caribbean Development Bank about possible BGS involvement in groundwater resources investigations in St Lucia and this may be followed by a visit and preparation of a proposal to the Bank by BGS.

10. BARBADOS

10.1 R & D Programme

Groundwater Pollution Studies. A visit was made to Barbados in October 1987 to set up a programme of groundwater quality monitoring to investigate the effects of intensive agricultural activities - fertiliser and pesticides - on groundwater quality. Surveys of fertiliser and pesticide use and potential sources of industrial pollution have been completed and a report on the assessment of pollution risk from agricultural, industrial and domestic sanitation has been prepared. Further visits were made in March, June and November, 1988. The June visit coincided with the presentation of a paper on the Groundwater Pollution Studies at a Pan American Health Organisation regional meeting in Puerto Rico. Further visits were made in July and November 1989. It is proposed to carry out a small drilling investigation in 1990, and a visit is planned for May or June 1990. A paper on the work in Barbados has been accepted for the 4th Caribbean Islands water congress in July 1990. The project is planned for completion in 1991 (P J Chilton).

D AFRICA AND THE MIDDLE EAST

1. BOTSWANA

1.1 BGS Secondments (OSAS and Key-Cadre)

R L Hargreaves remains seconded as Hydrogeologist to the Botswana Geological Survey Department where she is concerned with the computerisation of borehole records, supervising the groundwater monitoring networks and training local staff to take over management of these activities when her post is localised in mid-1992. D P Piper continues to fill the post of Principal Geologist in charge of the regional mapping programme.

1.2 R & D Progect

J Ridgway and T K Ball visited the Lake Ngami area in connection with the Gas and Vegetation Geochemistry in the Search for Buried Ore Deposits Project where, in a previously drilled area, gas, soil, vegetation and soil bacteria samples were collected for analysis in the UK.

2. EGYPT

2.1 TC Project

Under a professional linkage project, which began in October 1989, three BGS geologists, E A O'Connor, R N Annells and S Robertson have assisted the Egyptian Geological Survey by providing, on a non-residential basis, professional advice and supervision in the field with a view to improving the capability of the Survey to produce 1:250 000 geological maps. In addition two Egyptian geologists compiled their resulting maps at Keyworth under supervision.

2.2 R & D Programme

Staff concerned with the Mineral Development in the Third World project D J Morgan and S D J Inglethorpe, have provided to the Egyptian Geological Survey consultancy services in the field of clays and other industrial minerals and, in particular, made recommendations on how the Survey should develop its facilities to deal with these materials.

2.3 Advisory

Maghara Coal Project. The Mining Adviser was involved in extensive monitoring activity as this project progressed to the initial stages of equipment procurement.

West Sabaeya Phosphate. The Mining Adviser had limited monitoring involvement in this project, the construction phase of which is almost complete. Some operator training and TC operational assistance continue.

3. JORDAN

3.1 TC Programme

A new phase of the project designed to support the Jordan Natural Resources Authority began recently. The residential team comprises T C Charsley (Project Manager), I J Andrews (Stratigrapher/Sedimentologist) and D C Royce (Cartographer). The Phase II project has four aspects, firstly, continuing to provide advice and training on the 1:50 000 mapping and cartographical programme, secondly, assisting with the archiving, retrieval and dissemination of the large amount of geological information held within the organisation, thirdly, interpreting and improving the database by undertaking an appraisal of subsurface information and, fourthly, guiding the NRA in its programme of exploration for geothermal energy. The first three functions are carried out by the residential staff the fourth through short term consultancies by BGS staff coordinated by D J Allen.

4. KENYA

4.1 TC Programmes

Exploration for Geothermal Energy Project. Stage II of this project continued to assess the geothermal potential of four dormant volcanoes in the Kenya Rift Valley between Lakes Baringo and Turkana. Two resident geologists P N Dunkley (Project Manager) and M Smith are supported by visiting specialists. A hydrogeologist D J Allen and a hydrochemist, W G Darling have interpreted and reported on data they have collected from the Rift Valley.

The Geological Survey Editorial and Reporting Project. This project continued with the position of Reporting Adviser filled by P N Mosley. This project aims to restart the publication programme of the Geological Survey Department by, firstly eliminating the backlog of unpublished manuscripts and, secondly, training Kenyan staff in report writing and preparing maps and reports for the printer. A consultancy in computer applications was provided by R C Jones.

5. MALAWI

5.1 TC Programmes

B A Klinck continues in his post as Field Mapping Training Officer with the Geological Survey Department. A J Bloodworth completed two short assignments during which he provided on-the-job training in the evaluation of ceramic and other industrial minerals. A consultancy in computer applications was provided by R C Jones.

6. ST HELENA

6.1 TC Programmes

Horizontal Drilling. This project began in 1983. Drilling of shallow, horizontal and vertical boreholes into the perched aquifers in the basaltic lavas is continuing under the supervision of the Public Works Department (St Helena). A liaison visit by BGS took place in April 1987 (A R Lawrence).

7. SENEGAL

7.1 TC Programme

Groundwater Recharge Project. This project which commenced in July 1987 is designed to provide improved and integrated estimates of recharge and recharge history in a cross section of the Sahel where there has been a rather variable climate during the last two decades. Long term estimates of recharge are being obtained using the chloride mass balance technique developed in Cyprus and Sudan. The geochemistry of pore waters is being studied both directly on centrifuge extracted fluids (isotope and chemical parameters) and on elutriated samples. Throughout the project every effort has been made to simplify the sampling procedure thus making it suitable for widespread use in developing countries. This project is in collaboration with the Universite de Dakar and the Universite de Paris-Sud (W M Edmunds, Project Leader). This project will finish mid-1990 when, it is hoped, a workshop will be held in Senegal to help disseminate the technique for measuring recharge to all interested government parties.

8. ZIMBABWE

8.1 TC Programmes

Work continued on preparing for publication the results of the **Geological Mapping and Mineral Exploration Project.** Printing and publication of three bulletins presenting the results of the project is being undertaken by BGS for the Zimbabwe Geological Survey. D Bushell (on secondment from DOE) P Turner and G Wood remain in Zimbabwe as cartographers; G R Wood returns to BGS in April.

The two-man mineral exploration and institution building project **Integrated Exploration, Midlands Goldfield, Zimbabwe,** which has P E J Pitfield and S D G Campbell in residence has two objectives, firstly, to determine the structural geology of the goldfield and the relationship between mineralisation and structure to assist in finding targets for private sector exploration and, secondly, to introduce into the Geological Survey Department modern methods of structural mapping and analysis. A consultancy on computer applications was provided by R C Jones.

A new project to support the Geological Survey Department by filling through Key-Cadre arrangements established posts of Editorial Geologist, Chief Economic Geologist (training) and Principal Field Geologist (training) will shortly begin with the arrival of the editor.

Mr P Sinnett-Jones remains seconded to the Department of Water Resources and Development as Chief Hydrogeologist.

8.2 R & D Programme

The objectives of the **Development of Small-Scale Irrigation Systems Using Limited Shallow Groundwater Resources Project** are to combine the collector well techinque of groundwater abstraction from shallow, low permeability aquifers with methods of efficient irrigation, to make maximum use of the

limited groundwater resources of weathered basement. The first well has been completed in the Chiredzi area, permanent pumping plant installed and irrigation trials begun. Sites for further wells are under investigation.

The Development of Horizontal Drilling Rig for Alluvial Aquifers of High Permeability Project aims to adapt and extend collector well techniques successfully tested under a previous project to alluvial aquifers. After preliminary work in the UK, trials will be undertaken in Zimbabwe later in the year.

A report arising from a desk-study undertaken under the auspices of the **Appraisal and Removal of Iron Problems in Rural Groundwater Project** has been widely distributed and a positive response received from Zimbabwe amongst other places.

The aims of the **Development of Techniques for Hydrogeological Mapping and the Siting of Boreholes and Dug Wells Project** is to test various methods including remote sensing and geophysical methods which can be used to improve borehole and dug well success rate in arid and semi-arid areas. Orientation studies have recently been completed in Zimbabwe by D Greenbaum.

The new **Assessment of Hydraulic Fracturing in the Basement Aquifers of Zimbabwe project** aims to assess the application and use of the hydraulic fracturing technique to improve the water supply from low yielding boreholes in rural areas of Zimbabwe.

9. ZAMBIA

9.1 Mining Adviser

ODA's long-term assistance to Zambia's Ministry of Mines, administered by BDDSA, came under review. Discussions with ministry officials led to recommendations for continued support OSAS personnel in the Mines Safety Department. Projects with aid potential were identified in the Geological Survey Department and passed to BGS Keyworth for expert advice.

10. GHANA

10.1 Mining Adviser

An ATP proposal for the provision of equipment for rehabilitation of diamond mining operations in Ghana was reviewed. Thus far, the adviser has been unable to support the proposal, but additional information has been made available.

11. REGIONAL ACTIVITIES

11.1 R & D Projects

An information leaflet resulting from an R & D funded investigation of **Iron problems in rural groundwater supplies** is currently awaiting printing prior to wide distribution to relevant organisations in developing countries. Cooperative projects to further investigate the nature of iron problems in groundwater, resulting from the current R & D project are being discussed with organisations in a number of developing countries in Africa.

Further moling trials have been completed in connection with the **Radial wells in alluvium** project. These took place at a UK site in a deep well typical of sand river conditions. A two inch diameter plastic well screen was successfully pulled out to 20 m by a moling rig in less than half an hour. It is now planned to test a universally applicable technique suitable for even very fine sands. Work also continues in **Zimbabwe** where a suitable site for the construction of riverside collector wells was investigated in March.

The Mineral Resource Development in the Third World project is a response to the current trend for new mining projects in developing countries to be primarily concerned with minerals for local use rather than for export. Work carried out in Africa in the period under review includes the application of high intensity magnetic separation techniques to produce lithium-bearing minerals from alkaline igneous rock and the use of air classification to concentrate apatite, potentially a phosphate fertiliser, from Africa carbonatites. A visit to **Egypt** was made in order to assess alternative to Nile silts for indigenous brick manufacture and additional visits were made to **Zambia, Lesotho** and **Swaziland.**

12. COMMERCIAL AND COLLABORATIVE WORK

R A Annells undertook investigations of chromite deposits in Oman under contract to Robertsons Research, and R L Johnson has undertaken a short consultancy in Uganda for the same company.

A Miller undertook an ADB funded consultancy in the Development of Goephysical Laboratory Facilities in Indonesia.

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