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Geological Survey**

NATURAL ENVIRONMENT RESEARCH COUNCIL

# Nirex Geological Archive

A report produced for United Kingdom Nirex Limited

Information Management Programme

Commissioned Report CR/01/075N



BRITISH GEOLOGICAL SURVEY

COMMISSIONED REPORT CR/01/075N

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R P Shaw, N J Fortey, G Turner, S J Kemp, C Wheatley, W J Rowley and G R Baker

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Stillages of boxed Nirex core being unloaded at Keyworth.

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# Foreword

This report provides details of the Nirex geological archive that was transferred from Nirex to the British Geological Survey (BGS) during 2000/2001. The archive consists of borehole cores and samples, thin and polished sections, digital data and paper records acquired by Nirex during its investigations at Sellafield and Dounreay.

The BGS has undertaken to retain the records for a minimum of 50 years as part of its national geological archive.

This report has been prepared to record the transfer of the archive and briefly describes the nature and the extent of the data transferred to the BGS.

This report has been prepared, verified and approved for publication by the British Geological Survey. The work was carried out in accordance with the quality assurance arrangements that have been established by the BGS and Nirex and comply with the requirements of ISO 9001.

This report is made available under Nirex's Transparency Policy. In line with this policy, Nirex is seeking to make information on its activities readily available, and to enable interested parties to have access to and influence on its future programmes. The report may be freely used for non-commercial purposes. However, all commercial uses, including copying and re-publication, require permission from the BGS or Nirex. All copyright, database rights and other intellectual property rights reside with Nirex and the BGS. Applications for permission to use the report commercially should be made to the BGS or to Nirex. Commercial access to or use of the archive is by agreement with Nirex, but there are no restrictions on academic access to the archive.

Although great care has been taken to ensure the accuracy and completeness of the information contained in this publication, the BGS and Nirex cannot assume any responsibility for the consequences that may arise from its use by other parties.

If you would like to see other reports available from Nirex, a complete listing can be viewed at [www.nirex.co.uk](http://www.nirex.co.uk), or please write to Corporate Communications at the address below, or e-mail [info@nirex.co.uk](mailto:info@nirex.co.uk).

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# Summary

In July 2000 the BGS finalised an agreement with United Kingdom Nirex Limited for the transfer of the Nirex Geological Archive to the BGS to ensure that the unique data would remain available for the national benefit. The archive was acquired during the Nirex geological investigations of the Sellafield and Dounreay areas between 1989 and 1997 as part of its programme to determine whether one of the areas might be a suitable location of a deep repository for the disposal of radioactive waste.

By the end of 2000 the archive had been moved to the BGS headquarters at Keyworth. Subsequently, the various parts of the archive have been integrated with the national collections held by the BGS and prepared for long term preservation.

The archive has been moved to permanent storage locations and normal BGS arrangements will apply for non-commercial (academic) access to the material. Commercial access to the archive is by individual agreement with Nirex.

# 1 Introduction

In July 2000 the BGS came to agreement with United Kingdom Nirex Limited for the transfer of its geological archive to the BGS to ensure that the unique data would remain available for the national benefit. The archive was acquired during the Nirex geological investigations at Sellafield and Dounreay between 1989 and 1997 (Nirex, 2002).

The archive consists of:

- Borehole cores and subsamples:
  - approximately 20 km of core and 15 000 samples from 28 deep boreholes at Sellafield and two at Dounreay;
  - core plugs, thin and polished thin sections, SEM stubs and polished wafers tested during the site investigation programme at both sites.
- Magnetic data:
  - magnetic tape archive containing seismic survey data, borehole geophysical log data and airborne survey data;
  - Nirex Digital Geological Database (NDGD);
  - Sellafield Vulcan<sup>®</sup> and earthVision<sup>®</sup> 3-D models.
- Paper records:
  - Copies of borehole and geological reports prepared during the investigations.

The archive has been integrated into the national collections that the BGS holds and manages. The cores and samples have been repackaged into standard cardboard boxes and stacked in purpose made stillages. These have been transported to Keyworth and have been permanently housed in an extension to the core store built to house them, completed in June 2001 with financial support from Nirex. Where possible, core samples have been returned to their original position in the core.

The thin sections etc have been integrated into the BGS Britrocks collection. The Nirex Digital Geoscience Database (NDGD) and the 3D models have been added to the digital data holding in the BGS and the magnetic tape archive has been transcribed onto durable magnetic media for long term managed storage.

Approximately 250 bankers boxes of paper records, comprising of published Nirex reports on the geological investigations undertaken at Sellafield and Dounreay, have been integrated into the BGS borehole records collection and are housed in a dedicated section of storage.

Normal BGS arrangements will apply for non-commercial (academic) access to the material. Commercial access to or use of the archive is by individual agreement with Nirex.

## 2 Borehole cores and samples

The cores from 28 deep boreholes drilled at Sellafield and 2 drilled at Dounreay have been transferred from the wooden boxes, in which they have been stored since they were drilled, into purpose made cardboard boxes. The integrity of the original core box was maintained by the contents of each channel in the original core boxes being transferred to one cardboard box. At the time of transfer each new box was allocated unique numbers and curated into the BGS borehole core archive. A summary of the cores transferred to the BGS is given in Table 2.1.

Borehole	Length (metres)	Cored length (metres)	Comments
Sellafield			
1	773.04	324.04	Deviated
1A	1189.00	83.09	Deviated from BH1 with cored intervals below 815m
2	1610.00	1576.95	Vertical
3	1950.52	1256.92	Vertical
4	1260.00	849.00	Vertical
5	1260.00	1103.00	Vertical
7A	1010.00	549.00	Vertical
7B	471.00	407.00	Vertical
8A	1000.00	792.00	Vertical
8B	244.95	229.80	Vertical
9A	500.00	485.0	Vertical
9B	150.00	140.30	Vertical
10A	1607.86	1387.86	Vertical
10B	252.29	231.11	Vertical
11A	1170.00	369.00	Vertical
12A	1150.00	842.88	Vertical
13A	1740.00	639.00	Vertical
13B	295.70	259.87	Vertical
14A	873.00	538.00	Vertical
16	595.00	527.55	Vertical
RCF1	1150.00	770.00	Deviated
RCF2	1149.50	724.00	Deviated
RCF3	990.00	725.18	Vertical
RCM1	990.00	939.00	Vertical
RCM2	990.00	879.38	Vertical
RCM3	1035.00	630.50	Deviated
PRZ1	775.25	536.60	Inclined
PRZ2	560.00	325.00	Inclined
PRZ3	775.00	540.00	Inclined
Dounreay			
1	1322.00	1314.07	Vertical
2	960.00	951.00	Vertical

**Table 2.1** Summary of borehole core transferred to the BGS.

Samples that had been removed during the Nirex site characterisation work, mainly for the Core Characterisation Programme, and which were available at the time of transfer, were replaced in the core boxes. Samples that were held elsewhere or were overlooked during the bulk core re-packaging have been separately curated and will be replaced in the cores as and when the cores are examined in future.

Copies of the annotated transfer logs have been retained and can be consulted. These provide information on samples that were missing at the time of transfer and observations made during the transfer process.

### 3 Thin sections and other petrographic samples

Extensive collections and electronic records were assembled during a series of laboratory investigations carried out, mostly, by the former Mineralogy and Petrology Group (MPG) of the British Geological Survey in the early to mid 1990s, and some carried out by field staff of the BGS. These investigations formed part of the site investigations carried out at Sellafield and, to a lesser extent, Dounreay.

The integration of the petrological samples and related digital records arising from these studies into the BGS collections consisted of the following activities:

- Log all relevant samples and subsamples in order to verify which can be readily made available for future investigations.
- Record their present storage locations within the BGS site at Keyworth.
- Determine the extent of electronic records relating to these samples and held on the Apple Macintosh databases within the (former) Mineralogy and Petrology Group.
- Transfer these databases into the BGS data architecture.
- Prepare a report recording these activities and metadata necessary to locate the samples/sub-samples and records for subsequent use (Fortey et al., 2001).

Most of the samples were selected from borehole cores by expert Core Examination Panels and then extracted and passed to MPG for investigation. Others were collected from surface exposure and Quaternary deposits by BGS field staff. During the site investigations, they were divided into subsamples intended for specific analyses. These included unused original sample, reference subsample, excess jaw crushed rock, excess milled rock, X-ray fluorescence pellets, X-ray diffraction sub-samples, chips mounted in aluminium stubs (for scanning electron microscope (SEM) analysis), doubly polished fluid inclusion wafers, covered thin sections and polished thin sections. However, it is important to appreciate that production of subsamples varied from sample to sample according to the analytical requirements at the time.

The sample collections are described as they were observed during integration into the BGS archive between November 2000 and January 2001 at the BGS Keyworth site. A small number of additional samples, from outcrop mapping work and the Nirex Quaternary boreholes held at the BGS Edinburgh office, were added to the information held at Keyworth. To undertake curation, a list of the Nirex samples registered by MPG was assembled and cross-checked against actual samples. In all, 2773 samples were identified from the MPG list. However, about 900 out of these were found to be missing, in that neither original sample nor reference subsample could be located (although some were still represented by other types of subsample). These had been transported back to the Nirex Cleator Moor core store upon completion of laboratory testing and were re-inserted into the cores during the transfer of the core to cardboard boxes undertaken there prior to core shipment to Keyworth.

A further 474 samples were found that had not been registered by MPG. These are samples that were extracted from the cores at the Core Examination Panel to allow sufficient samples to be available for the agreed laboratory testing to be undertaken on samples representative of the lithologies present in each borehole, but were not subsequently selected for study and were set on one side and not used in the MPG investigations.

A total of 1261 thin sections prepared from samples registered by MPG were located and verified. To these were added 188 thin sections of surface exposure samples of BVG (Borrowdale Volcanic Group), and a further 15 thin sections of Quaternary deposits that are currently held at the BGS Edinburgh office.

During the curation process, a record of samples, containers and locations was assembled as a set of related Excel97 spreadsheet tables. These were copied into a set of tables in Access97. When completed, this database was incorporated into a new Oracle relational database for the Nirex

petrological samples. This is held on the BGS database server and forms part of the BGS database architecture.

## 4 Magnetic tape archive

### 4.1 DESCRIPTION OF DATASET

The archive transfer included all the digital geophysical data (from surface, airborne and borehole surveys) acquired by Nirex and held in their tape archive. A significant part of this data collection is geophysical survey data in digital form, a mixture of instrument recordings made during fieldwork and derived data created during the subsequent processing and interpretation of field data. These data were originally stored on a variety of media. With the overall aim of delivering an efficient and effective archive service but also minimising its overhead costs, the BGS has consolidated the bulk of these data onto DLT (digital linear tape) cartridges. Some related data that were either analogue, on obscure media or in unknown formats have been retained in their original form and may not be recoverable in future. Similarly, flight line videos have been retained as supplied.

Duplicate copies of the data held on DLTs are stored by Spectrum Energy & IT, the BGS's data transcription contractor for this project, to serve as an off-site backup and an alternative source of data supply.

The data are well-catalogued and the catalogue is available to the BGS Enquiry Service. It is in the form of an Access database and includes the following: original media type, identification numbers, date allocated and observed damage; data source, type and format; text description.

### 4.2 SUMMARY OF DATA AVAILABLE

Geographic areas: Sellafield (Cumbria, NW England); Dounreay (Caithness, N Scotland).

Seismic surveys: Marine, land and transition zone; field, navigation, statics, demultiplexed and processed data.

Borehole logging: routine wireline logging of investigation boreholes (gamma-ray, sonic, porosity, etc.); velocity surveys; dipmeter surveys; vertical seismic profiles (VSPs); borehole imagery surveys; synthetic seismograms; cross-hole tomography.

Ground surveys: magnetic; gravity; radiometric; groundwater; salinity mapping.

Airborne surveys: aeromagnetic; radiometric; thermal imaging; photographic imaging; flightline videos.

### 4.3 ENQUIRIES AND DATA SUPPLY

As part of its agreement with Nirex, the BGS will make data from the archive available to third parties. BGS will achieve this through its existing enquiries and data licensing systems. Procedures similar to those currently used for handling the Coal Authority Geophysical Data Collection will be applied.

The BGS Enquiry Service will deal with any enquiries about the data, supplying details of geographic areas covered, data types held, media, terms & conditions of supply and costs. For academic research purposes, only the BGS charges may apply. For commercial use a scale of fees agreed with Nirex shall additionally apply. It is possible that in the future the catalogue information may be linked to the BGS web-based geographic information system (GDI), so that enquirers may search and order through the BGS e-commerce site.

Data will be supplied in two different ways based on the two categories of data held:

- Digital Data on DLT Cartridges. The BGS will recover the required file(s) from the DLT archive cartridges and supply them on new media, e.g. CD-ROM or Exabyte tape. (At its

discretion, the BGS may delegate this work to Spectrum Energy & IT.) In this case the purchaser will receive a copy of the data for their retention. Their use of this data will be governed by a BGS Data User Agreement, which will be agreed and signed by both parties prior to supply of data.

- Related data on original media. The BGS will lend the original media to the purchaser for a specified period. In this case their use of the data will be governed by a BGS Data Loan Agreement, which will be agreed and signed by both parties prior to supply of data. As part of the agreement the purchaser will undertake liability for loss or damage whilst the data are in their care.

## 5 Digital data and three-dimensional models

All original supplied media (CD\_ROM, DAT, magnetic tapes and 3.5" disks) have been archived within the BGS tape archive to ensure correct storage conditions.

### 5.1 ORACLE DATA

Several Oracle databases have been retrieved from archive tape and restored on BGS servers. Queries upon these datasets should be directed initially to Richard Shaw (rps@bgs.ac.uk) or Garry Baker (grba@bgs.ac.uk).

Nirex Digital Geoscience Database (NDGD): the final copy of the NDGD (as per mothballing the NDGD contract) has been restored upon the BGS Keyworth Oracle database server. The data are held in the NDGD schema.

Nirex Groundwater Geoscience Database (NGWD): the final version of the NGWD has been restored upon the BGS Keyworth Oracle database server as received from GeoScience Ltd via United Kingdom Nirex Ltd. These data are held in the NIREX\_NGWD schema. The data are currently held as supplied and will require some rebuilding of database keys before complex queries can be run against the data.

Long Term Monitoring System (LTMS): the collated DAT of long-term monitoring data from the Nirex deep boreholes in the Sellafield area has been stored upon the BGS Keyworth Oracle database server. These data are held in the NIREX\_LTMS schema. These data have been restored in the format that they were exported to the DAT tape for archiving. Queries to be run against this data will require time to build and remedial work against table design or table key development is likely to be required.

WIMTEC Database: this was a database of the on-site chemical analyses of groundwater samples from the Nirex deep boreholes. Data files are in Oracle 8 dmp format, which will be loaded onto the BGS Oracle database once BGS has completed upgrade to Oracle 8i (expected latter part of 2002). The BGS are currently at Oracle version 7.3.4 and so have stored the data file for future extraction.

### 5.2 3-D MODELLING DATA

EarthVision<sup>®</sup> Models: the supplied DAT tapes of Nirex models, using earthVision<sup>®</sup> software, of the 2-D/3-D geological structure of the Sellafield area, particularly the Potential Repository Zone at Longlands Farm, have been loaded on a UNIX server which houses the BGS earthVision<sup>®</sup> 2-D/3-D software. Queries against these models should be agreed through Richard Shaw (rps@bgs.ac.uk). Please note that as the BGS has limited licenses of earthVision<sup>®</sup>, there may at certain times be a delay in being able to access the models.

Vulcan<sup>®</sup> Models: The supplied DAT tapes of Nirex models using Vulcan<sup>®</sup> software of the 3-D geological structure of the Potential Repository Zone and Rock Characterisation Facility at Longlands Farm have been loaded on a corporate BGS NT data server. Queries against these models should be agreed through Richard Shaw (rps@bgs.ac.uk). Please note that BGS has limited licenses of Vulcan<sup>®</sup> and that at busy periods there might be a delay in accessing these models.

Both these sets of models are currently held 'as supplied' compatible with the versions of earthVision<sup>®</sup> and Vulcan<sup>®</sup> that were current when they were developed. Significantly upgraded versions of both modelling packages have since been released and these models are no longer fully compatible with the recent releases. The BGS hopes to be able to up-grade the models to the current software versions by 2004.

### 5.3 MISCELLANEOUS DIGITAL DATASETS

A number of miscellaneous digital datasets are held upon the BGS corporate data NT server in a structured set of directories. Access to any datasets in this section is via Richard Shaw (rps@bgs.ac.uk).

Data model: the data model for the NDGD as designed within SELECT SE is stored in both zipped and live formats for use by database designers. The files are stored in a directory called 'Data Model'.

Geophysics datasets: various geophysics datasets compiled by Geoff Kimbell (BGS) (including the Digital Terrain Models (DTM's)) are stored in a directory called 'Geophysics Datasets'.

IKODA Seismic Data: the single large zipped 'fin\_fuzz.z' is stored upon a directory called 'IKODA\_SEISMIC\_IMP'. This is a data set derived from the processing of the 3-D trial seismic survey carried out over the RCF/PRZ. This file is stored as supplied upon the DAT. It has been assumed that any access to the seismic acoustic impedance data would require the entire dataset and the compressed file is the best option for the storage of that file.

WIMTEC data: the WIMTEC data were extracted from a GUPTA SQLBASE 5.2 database as a series of files containing both the data, table design, table constraints and keys. These files are stored as extracted from the GUPTA product, as significant work would be required to rebuild and constrain the tables in Oracle and populate them. It was agreed that these files would be stored as supplied with any queries against these data picking up the cost of rebuilding the database tables. These data have been subsequently worked upon to extract them from of GUPTA SQLBase 5.2 format and into Oracle dmp format.

General 'Sellafield' data: a variety of data was loaded upon the Nirex NDGD PC as supplied at the end of the 'Mothballing NDGD' contract. These data are held in a series of structured sub-directories.

- SQL repository: a store of the SQL created for the NDGD help desk queries which can be re-used to create new queries against the NDGD in the future.
- Near surface geochemistry: this dataset was never loaded upon the NDGD because it arrived too late for inclusion in the full database.
- 'Nirex 97': An archive of all the digital files created for the 'Nirex 97' performance assessment reported in *An Assessment of the Post-closure Performance of a Deep Waste Repository at Sellafield* (Nirex Report S/97/012 (5 volumes)).
- In situ stress diagrams: rock stress diagrams created from the Sellafield data.
- Vulcan<sup>®</sup> SQL files: SQL files created for the export of NDGD data in a Vulcan<sup>®</sup> accessible format.
- NDGD Manual: the NDGD manual in both MS-Word (.doc) and Adobe Acrobat (.pdf) formats, parts 1 to 3 including appendices and figures.
- 'Baseline archive': an archive of all the digital files created for the 'Baseline' archive reports (*RCF: Report on Baseline Groundwater Pressures and Hydrochemistry* (Nirex Report SA/96/006)).
- TVD calculations: SQL files used to calculate the true vertical depths (TVD) of the boreholes drilled at Sellafield.

## 6 Reports

Copies of geological reports, some 2500 volumes, from the Nirex Sellafield and Dounreay site investigations have been lodged with the BGS. These reports have been integrated into the BGS borehole records and will be retained as an integrated 'Nirex collection'. They are stored in a dedicated section of the borehole records collection and can be consulted at Keyworth by prior arrangement. A digital catalogue of these reports is kept as part of the BGS borehole records catalogue.

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