



British  
Geological Survey

NATURAL ENVIRONMENT RESEARCH COUNCIL



[www.bgs.ac.uk](http://www.bgs.ac.uk)

# Oracle Spatial Special Interest Group Presentation

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# Scope of talk

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- History of Oracle in BGS
  - Different data and different applications
  - The Spatial Story
  - Parallel Paths
  - Can Oracle Spatial Help unify RDBMS and GIS?
- 
- Why Oracle spatial
  - The role of spatial database technology
  - Example Data
  - Methods used to spatially enable Oracle tables
  - Example code for the various methods
  - Mechanisms used to update geometry
  - Best of the RDBMS & GIS worlds



# History of Oracle in BGS

[www.bgs.ac.uk](http://www.bgs.ac.uk)

- Oracle first introduced to BGS in 1983 running under VMS 4.2 on a VAX 8600 computer with 12Mb memory, 2.7 Gb disk space. User Interface was Oracle Forms and SQLPlus
- Initial relational designs were poor. No more than flat lists taken from paper systems (some still exist today)
- A menu driven interface was developed by BGS in the late 80's using ProFortran (MARS).
- The widespread introduction of PC's and Windows in the early 90's led to the use of Microsoft Access as the major user interface used to query Oracle data in BGS



# History of Oracle in BGS

[www.bgs.ac.uk](http://www.bgs.ac.uk)

- 1999 saw the development of a BGS web based interface to Oracle called Intranet Data Access (IDA). This is still in use today and relies heavily on Cold Fusion to provide Intranet access to our Oracle databases



# Different data and different applications

[www.bgs.ac.uk](http://www.bgs.ac.uk)

- Relational
- GIS (spatial vector data as points, lines and polygons)
- GIS (spatial raster data with or without attributes)
- Surfaces (TINS and GRIDS)
- Images (e.g. borehole, map & photograph scans)
- Time series measurements
- Downhole measurements (depth series)
- 3D models
- etc



# Relational data on a web page (IDA)

IDA Main - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Address <http://intranet/resources/data/ida/ida/main.htm>

Google Search 17 blocked ABC Check AutoLink AutoFill Options

## IDA Menu

- NGRC IDA menu
  - Enquiries
  - Geoscience ImageBase (GIB)
  - Accessions/Site Investigations
  - Boreholes
  - Borehole Geology
  - Borehole Materials (BMD)
  - Lexicon Browser
  - Plans and Aerial Photos
  - Geological Maps
  - Geophysical Logs Index
  - BGS Reports
  - Offshore Reports
  - NGRC Loans and Archives
  - Coal and Waste Tips
  - Coal Authority Data
  - Land Survey Field Records
  - Land Survey Record Index
  - Memoirs
  - Palaeontology Data
  - Britrocks Database
  - Gazetteer
  - BGS Dictionaries
  - IDA Utilities
  - Geographic Searches
  - Geoscience home

## SOBI ~ Results Screen

A listing of the salient fields for the records corresponding to your search criteria is displayed. To edit a record, or to view the full record, click the links on the left hand side or [Try Another Query?](#)

[Format List for printing?](#) Rows 1 to 1000 1001 to 1303 of: 1303

[Download Results](#)

	QS	RT	NUMB	BSUFF	BORE NAME
	EAST	NORTH	DRILLED LENGTH	CONF.	
<a href="#">Full</a> <a href="#">Edit</a> <a href="#">View pdf</a>	SJ24NE	BJ	847	.	UNNAMED SHAFT
	328851	0346408		1	NO GEOLOGICAL DETAILS : NCB SHAFT NO. 367
<a href="#">Full</a> <a href="#">Edit</a> <a href="#">View pdf</a>	SJ24NE	BJ	848	.	UNNAMED SHAFT
	328906	0346398		1	NO GEOLOGICAL DETAILS : NCB SHAFT NO. 368
<a href="#">Full</a> <a href="#">Edit</a> <a href="#">View pdf</a>	SJ24NE	BJ	849	.	UNNAMED SHAFT
	329430	0346670		1	NO GEOLOGICAL DETAILS : NCB SHAFT NO. 369
<a href="#">Full</a> <a href="#">Edit</a> <a href="#">View pdf</a>	SJ24NE	BJ	850	.	UNNAMED SHAFT
	329090	0346456		1	NO GEOLOGICAL DETAILS : NCB SHAFT NO. 370
<a href="#">Full</a> <a href="#">Edit</a> <a href="#">View pdf</a>	SJ24NE	BJ	851	.	UNNAMED SHAFT
	329350	0346791		1	NO GEOLOGICAL DETAILS : NCB SHAFT NO. 371
<a href="#">Full</a> <a href="#">Edit</a> <a href="#">View pdf</a>	SJ24NE	BJ	852	.	GROES COLL., ENGINE PIT
	328361	0345166		1	NO GEOLOGICAL DETAILS : NCB SHAFT NO. 372

Done Local intranet

# Depth series information from borehole

www.bgs.ac.uk

SVG Geology Table - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Home Search Favorites Media Print View Source

Address http://kwntsintranet/scripts/resources/applications/borehole\_viewer/svgreportcolour.cfm?checklist= Go Links

Google Search Popups okay Check AutoLink

## SVG Viewer Data

Refresh SVG Plot

**BLACKBERRY HILLS NO 18**  
Non-confidential (Code : 1)

**SK63SW BJ 118 . (BNG E / N) 463364 0332618**

**Surface Level (m):** 68.4  
**Drilled Length (m):** 35.13  
**Entered by:** K\_PML19-Apr-90  
**Updated by:** BGS 06-Jun-03

Interval Details (Interpreter : DJLO)	Base Bed	Thickness	Depth (m)
<u>No strat code defined : unknown/unclassified entry</u> <u>OPEN HOLE+LOST - Original LITH1 was NOCO</u>	UNKNOWN ROCKHEAD	4.11	0 - 4.11
<u>(BNT) : limestone</u> <u>VF,MDDY,BRN/GY</u>		.44	4.11 - 4.55
<u>(BNT) : mudstone, calcareous</u> <u>GREY,BASE APPROX</u>		1.70	4.55 - 6.25
<u>(CTM) : limestone</u> <u>BRN+GREY,BANDED</u>		.15	6.25 - 6.4
<u>(CTM) : silicate-mudstone</u> <u>GREY,CALC,LAYS</u>		2.44	6.4 - 8.84
<u>(CTM) : silicate-siltstone</u> <u>FN,GREY,BNA</u>		.48	8.84 - 9.32
<u>(WBY) : silicate-mudstone</u> <u>OK,LAMI,SHEL</u>		1.48	9.32 - 10.8
<u>(WBY) : silicate-mudstone</u> <u>OK BNA FCH FISH</u>		4.97	10.8 - 15.77

Local intranet





# Scan of borehole log

www.bgs.ac.uk

**Borehole 233961 - PDF Logs - Microsoft Internet Explorer**

File Edit View Favorites Tools Help

Back Forward Stop Home Search Favorites Media Print View Source

Address <http://kwntsintranet/scripts/IDA/boreholescan/dispBorehole.cfm?bgsid=233961> Go Links

Google Search Popups okay Check AutoLink AutoFill Options

**PREVIOUS** SK63SW BJ 118 **Report Error** Con:1 Print All Page 1 of 3 (k) Original Low Res Help? **NEXT**

Save a Copy Search Select 75% Create an Adobe PDF from your desktop

**Pages**

**Attachments**

**Comments**

Form P.70 (Series 610) 6336 3262

8-inch Map SK 63 SW 118 Regd. No.

(County, Sheet and Qtr.)

63 W (Nat. Grid, Sheet and Qtr.)

Attach tracing from a map or sketch map if possible

SECTION OF BLACKBERRY HILLS NO.18

PURPOSE *Expl. - Proving*

EXACT SITE E 463 364 N 332 618

LEVEL AT WHICH <sup>shaft</sup> <sub>bore</sub> <sub>drift</sub> COMMENCED RELATIVE TO O.D. 224.34 *68.4*

DATE OF SINKING OR BORING *10/11/1961*

SINKER OR BORER *M.C.B.*

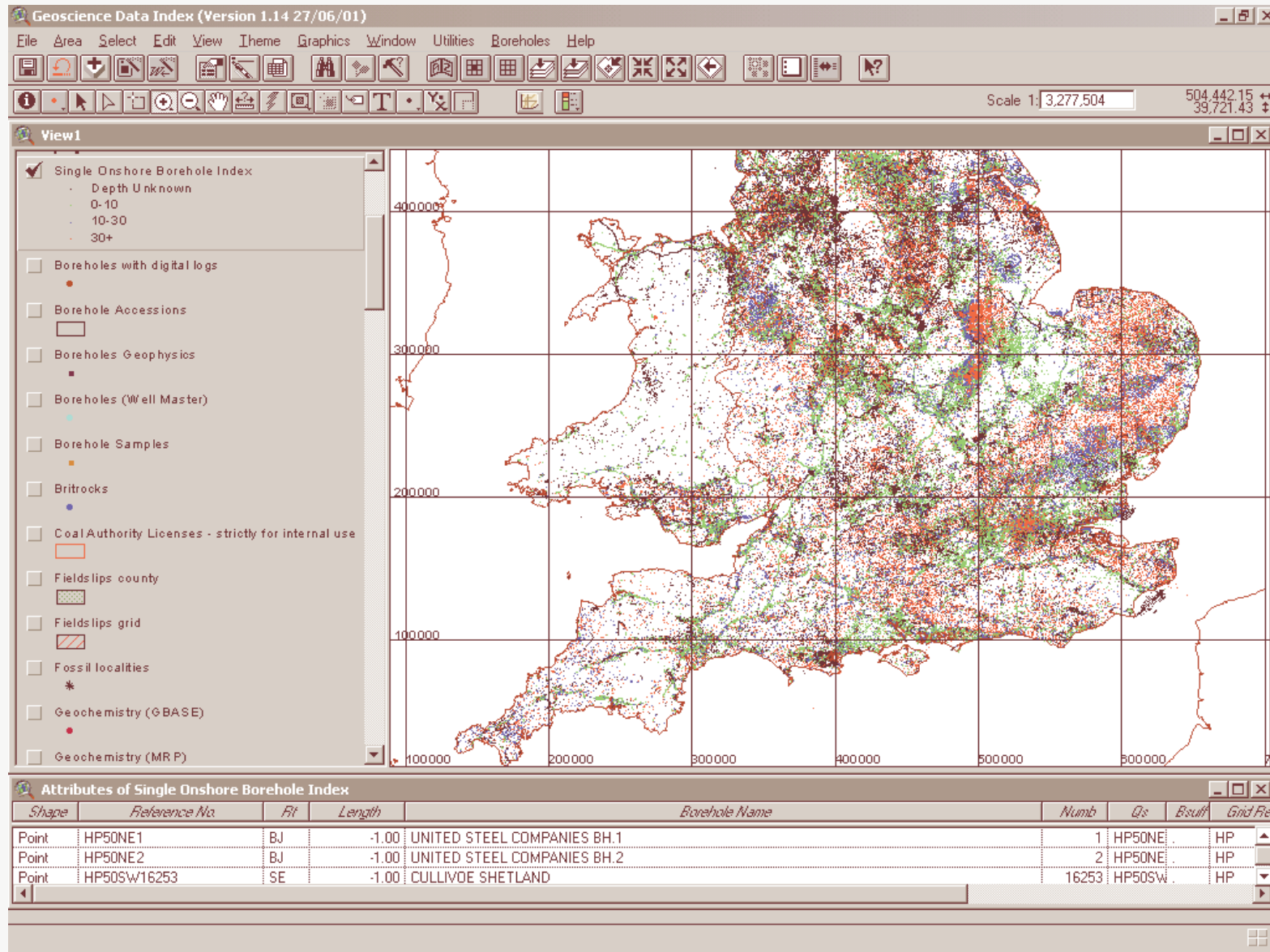
GEOLOGICAL CLASSIFICATION	NATURE OF STRATA	THICKNESS		DEPTH	
		FEET	IN.	FEET	IN.
	Water loss 13 ft.				
	Open hole			10	0
	Core lost 3'-6" pull-out			13	6
<u>LOWER LIAS</u> Limestone <i>Bot Han</i>	muddy, very fine grained, brown-grey; pyrites veins, brown-weathered joints	1	5	14	11 4.6
<u>UPPER RHARTIC</u> <i>Broken core</i> Mudstone, <i>Bot Han</i>	grey; calcareous, pale calcareous laminae pull-out	0	4+	17	0
<i>Broken core</i> Mudstone, <i>Bot Han</i>	grey; calcareous; even paler laminae, sharp	0	9+		5.4

*Chm*



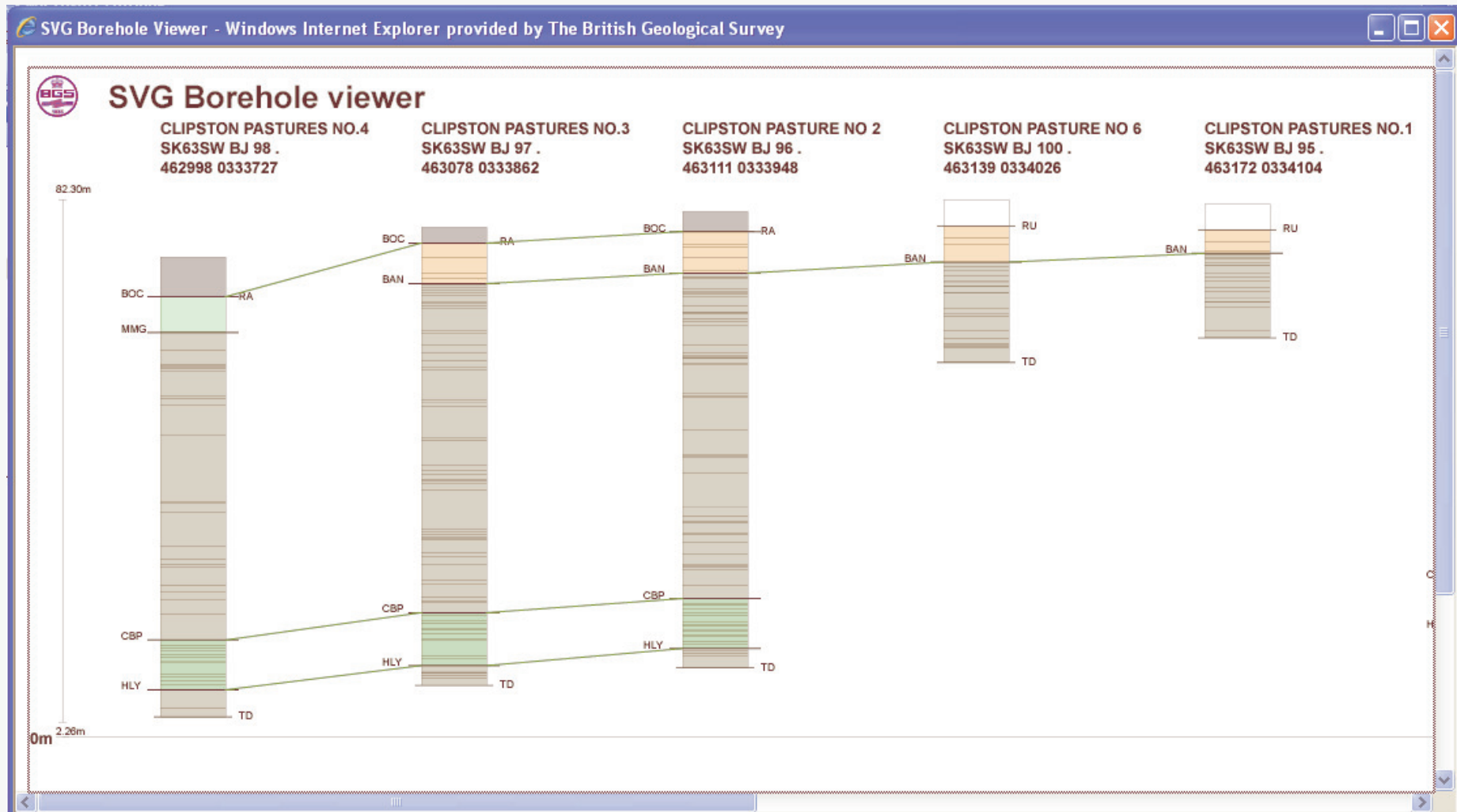
# GIS point data in ArcView 3

www.bgs.ac.uk



# SVG Borehole viewer

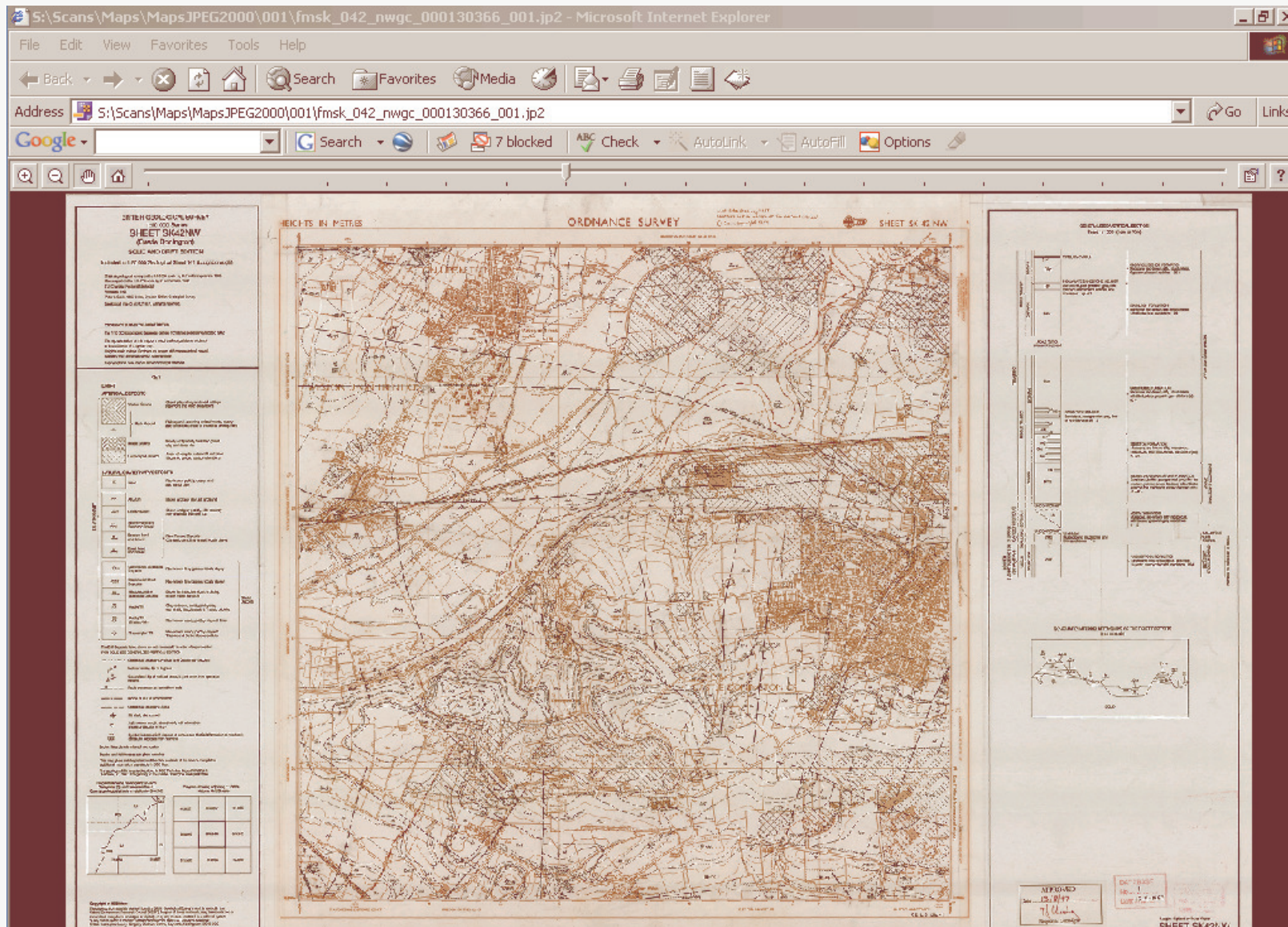
www.bgs.ac.uk





# Scanned map viewed in IE

www.bgs.ac.uk



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# GIS line data displayed in GeoIndex

www.bgs.ac.uk

Geoscience Data Index - Microsoft Internet Explorer

British Geological Survey Geoscience Data Index

Change Map Theme Offshore UK Data Enquiries Feedback Help

Click layer names for details

Current query layer: Geophysical survey lines

- ☐ Geophysical logs - digital
- ☐ Seabed samples
- ☐ Airborne magnetic surveys
  - Flight lines
- ☐ Gravity readings
- ☐ Magnetic readings
- ☒ Geophysical survey lines
- ☒ Median lines
- ☒ Quadrants
- ☒ Blocks
- ☒ Coastlines

Redraw Map Show Legend

Zoom in to activate greyed out data layers

Display

Navigate

Query

Printing

Reports

Query/Selection Results - Microsoft Internet Explorer

Geophysical survey lines

Zoom To	ID	YEAR	PROJ	LINE	FIX	Y	X	DEPTH	EQUIPMENT
1	1977229	1977	2	29	3	55.9534	-1.8684	68	Echo sounder, Gravimeter, Pinger,

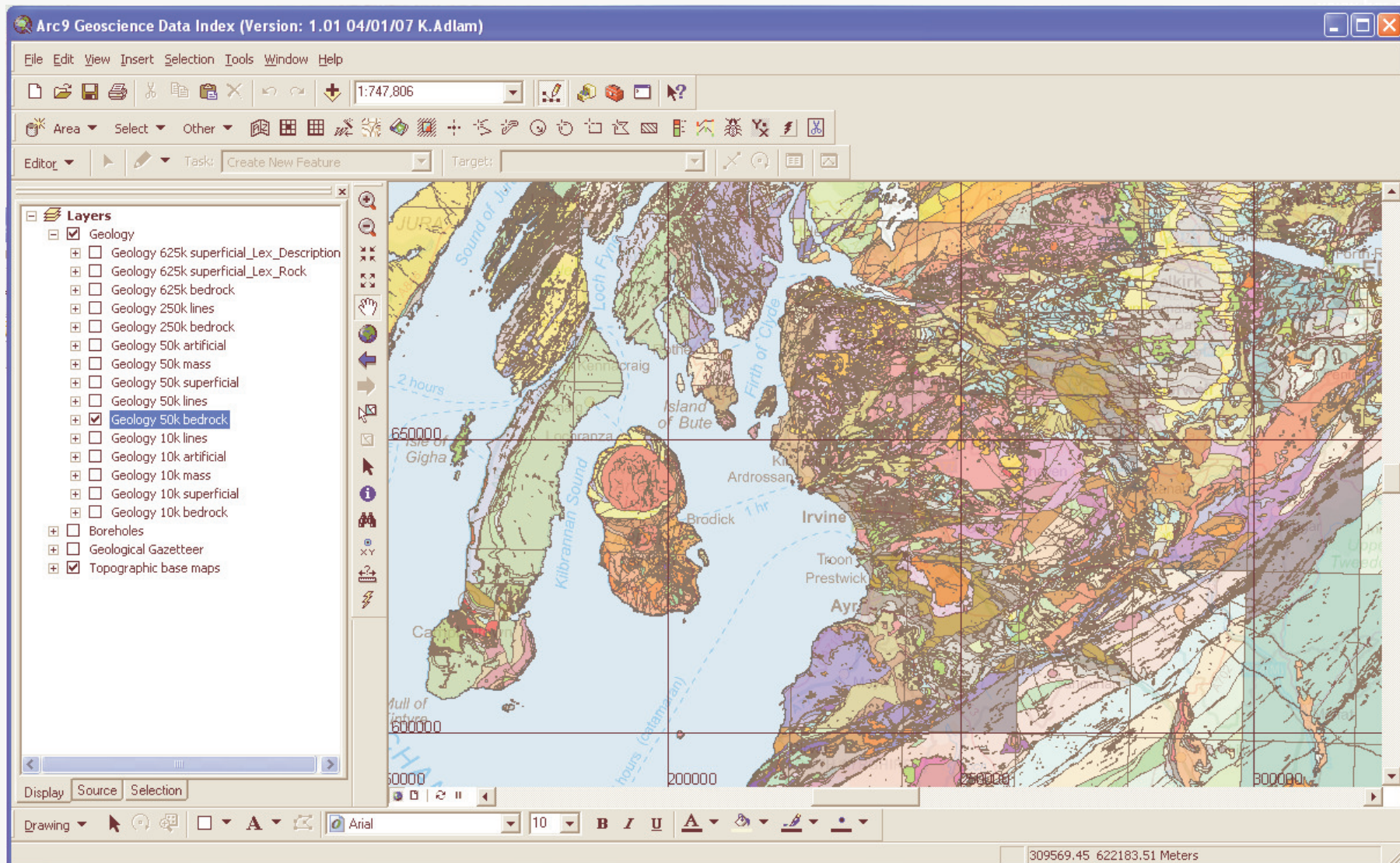
Identify

ED50 Lat: 56.1 Long: -2.3

Start My Docu... self self Conoco gdi\_off\_s... Geoscienc... Geoscienc... Query/S... 13:48

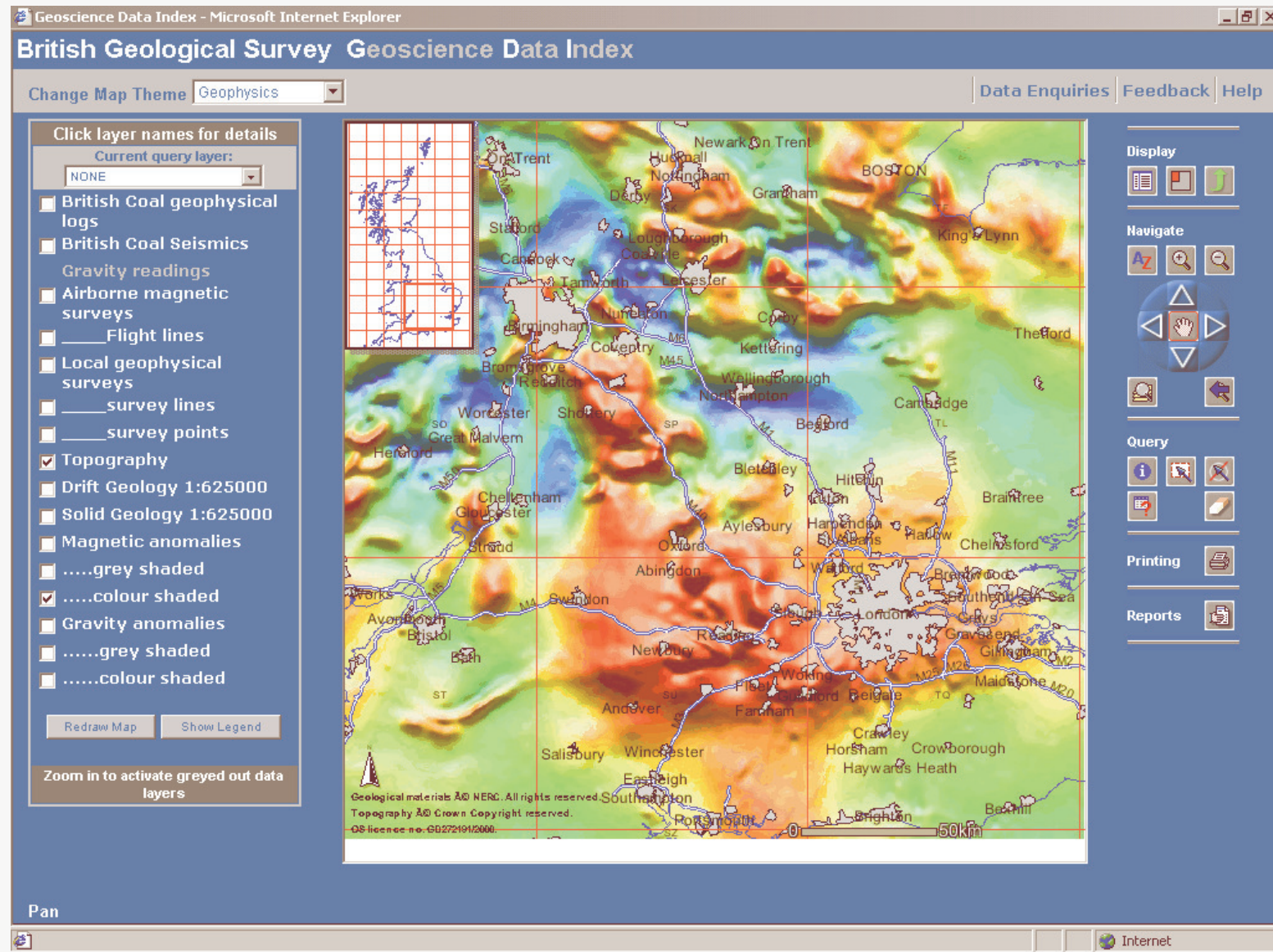


# GIS polygon data in ArcMap



# Raster data displayed in GeoIndex

www.bgs.ac.uk

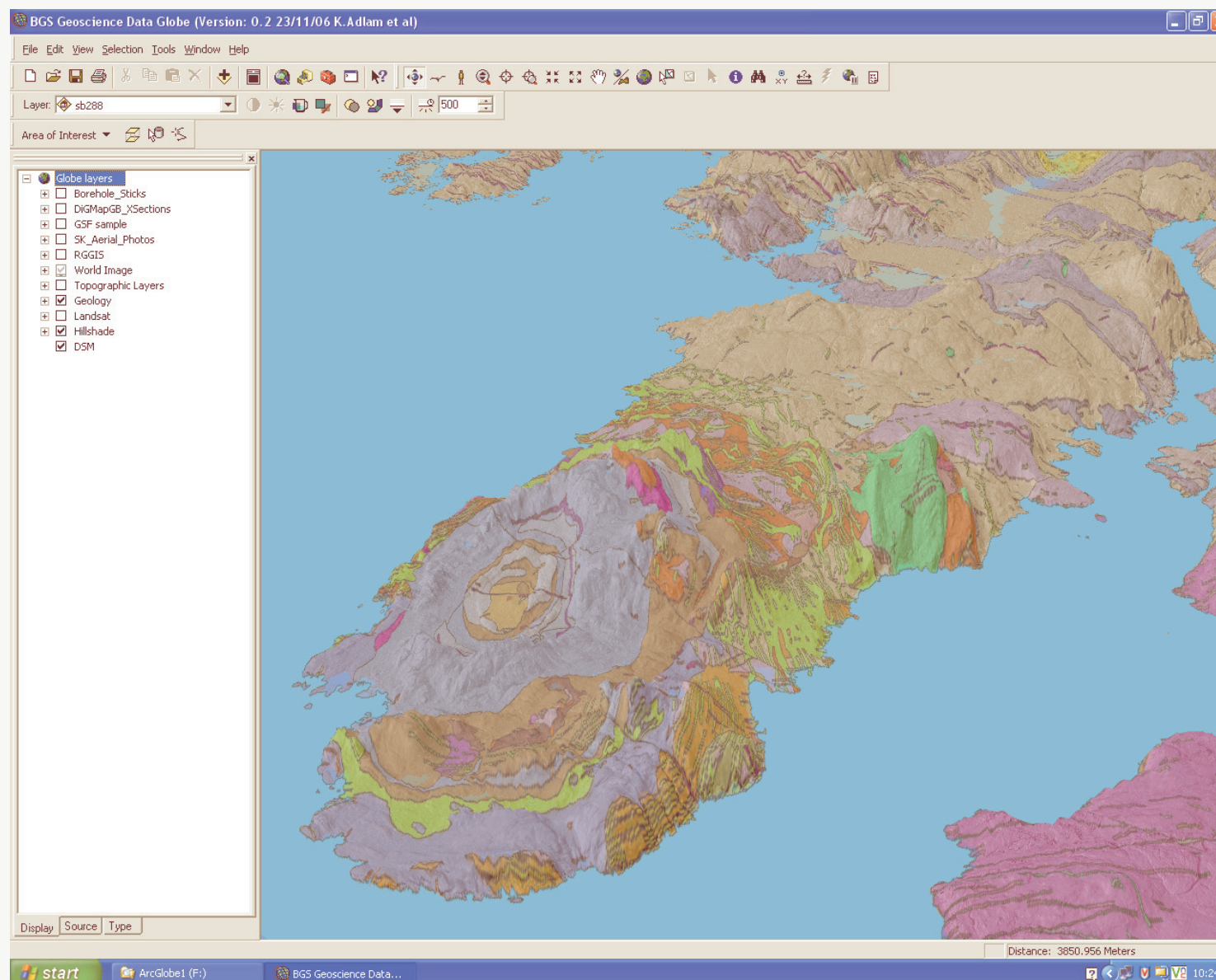


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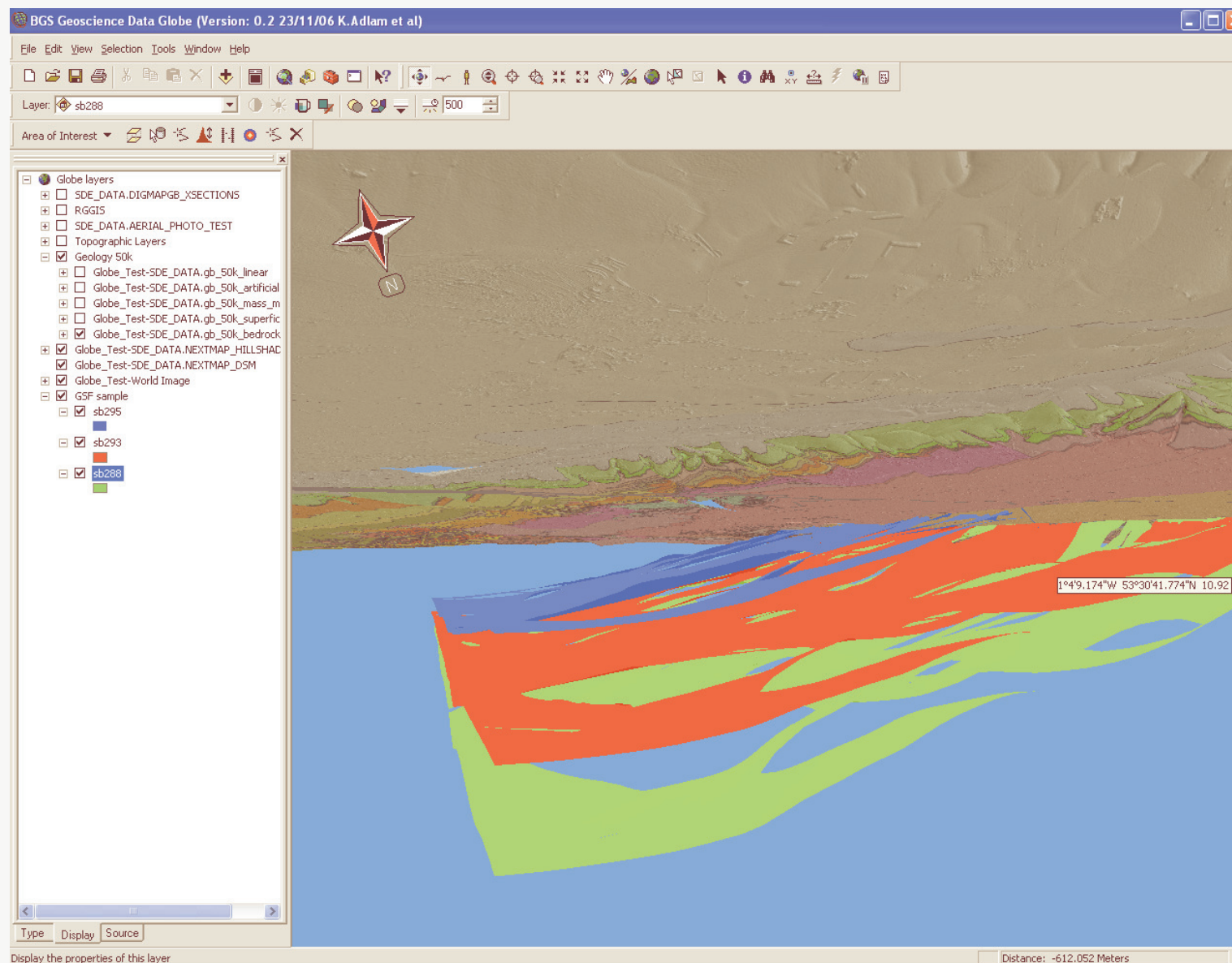
# Visualisation in ArcGlobe

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# Surfaces displayed in ArcGlobe

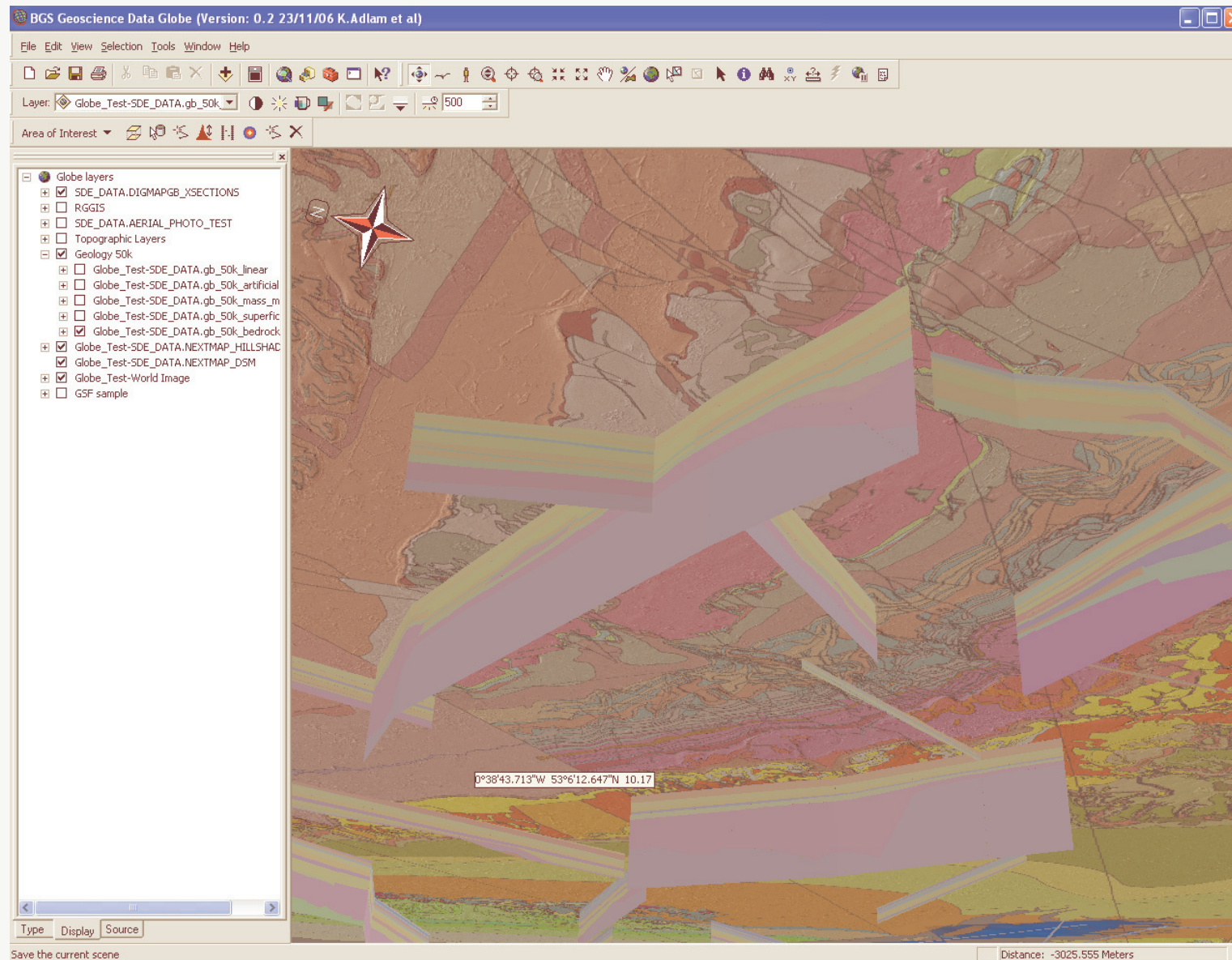
www.bgs.ac.uk



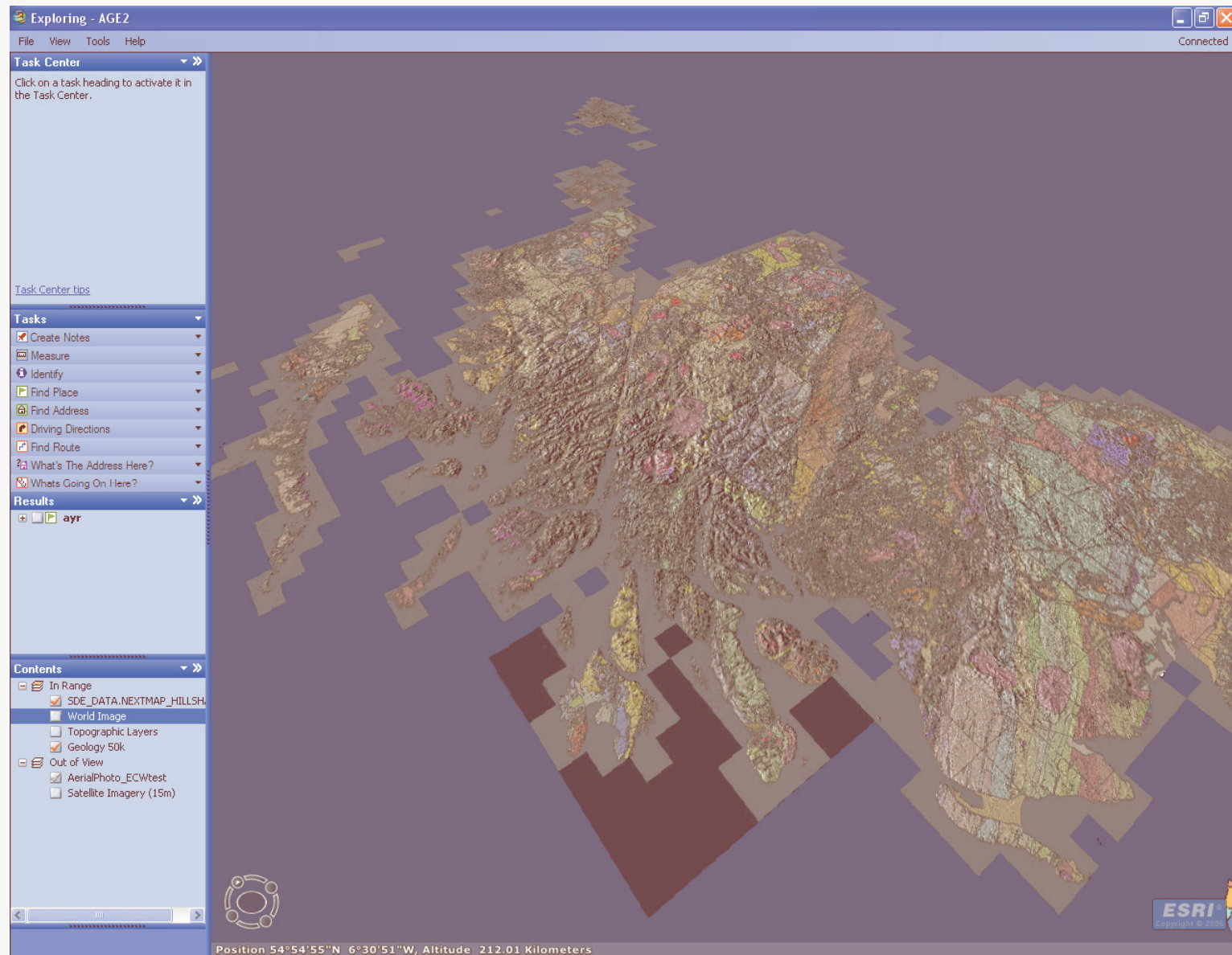


# Visualisation of cross-sections

www.bgs.ac.uk



# Visualisation in ArcGIS Explorer



www.bgs.ac.uk



# The Spatial Story

[www.bgs.ac.uk](http://www.bgs.ac.uk)

- During the time period that Oracle has been used within BGS for storing relational data, ESRI products have been used to store, manage, analyse and display GIS data
- In 1985 Arc/Info was first used to support the BGS Geoscience Data Index (GDI) This allowed visualisation, spatial query and analysis of many of our important datasets. Seats were limited due to the cost of the Unix workstations at the time
- Introduction of PC's and ArcView 3 in the early 90's led to widespread use of GIS in BGS





# The Spatial Story

[www.bgs.ac.uk](http://www.bgs.ac.uk)

- In 2000 BGS launched GeoIndex a web based version of the Geoscience Data Index. This is based on ESRI's ARCIMS and allows our customers to visualise and query, at the index level, some of our major dataset over the web.
- In addition to 2D GIS data BGS also holds 2.5D and 3D data in the form of cross-sections borehole data seismic section, stratum contours etc. Much of this data has been modelled using specialist modelling packages





# Parallel Paths

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- The previous slides have summarised the parallel developments in the use of GIS and RDBMS within BGS
- The two environments have developed side by side for over 20 years yet very little real integration has taken place between these two environments
- Yes, data has been shared between the environments but this has involved translations and copies of data



# Why Parallel Paths?

[www.bgs.ac.uk](http://www.bgs.ac.uk)

- GIS started life using proprietary file based formats designed to get the best performance possible
- Until the introduction of Spatial Data Option (SDO) Oracle did not support spatial data Only standard data types existed and indexes were limited to 2D B-Trees
- There was little opportunity for GIS and RDBMS developers to come together and create a unified data store to support both relational and spatial data
- The results was and still is two parallel environments, two parallel developments, two parallel sets of rules two parallel sets of data and two separate cultures



# Can Oracle Spatial Help unify RDBMS and GIS?

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- Oracle Spatial is seen as a way to start to bring the two parallel developments closer together
- To reduce movement of data between systems
- To have one central data repository that can be used to support both GIS and Relational environments
- During the initial phase we are concentrating on spatially enabling existing data held in Oracle excluding GIS data directly managed by ESRI's ArcSDE
- Many of our Oracle tables have a spatial component but this takes a number of different forms



# Types of location data in existing Oracle tables

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- X-Y coordinates (205936,387654)
- National grid reference (TQ38762768)
- Ordnance Survey tiles (TQ, TQ24NE etc.)
- Two Corner coordinates of rectangular areas
- Four corner coordinates of quadrilateral areas
- Line and polygon data held as ordered rows with x-y coordinates

ID,SEQ,X,Y

1,1,365709,456384

1,2,456890,468345

1,3,469670,476758



# Spatially enabling relational data current production situation

[www.bgs.ac.uk](http://www.bgs.ac.uk)

- Important relational datasets are translated to ESRI shapefile format on a monthly basis and held on a central fileserver
- This means that GIS users do not see the current state of the active database
- Small point datasets held in Oracle can be accessed directly from ArcGIS by creating an event theme but this is too slow for larger datasets as no spatial index is used.



# Some issues encountered

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- When using views that contain a geometry field we have found that they are extremely slow when accessed from other user schemas. It appears that the spatial index is only used if the user is the owner of the view or has MERGE ANY VIEW privilege
- It is possible to register an Oracle view with SDE but not possible to register a view with an ESRI Geodatabase. This means that ESRI domains, sub-types etc cannot be used against views.
- Editing using ESRI clients via views is not possible
- Editing related tables using ArcMap causes problems when constraints are present





# ESRI/Oracle Interoperability

## What is easy?

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- Interoperability at the simple level
- Can easily register Oracle Spatial tables with SDE (unique number, geometry).
- Can copy data held in ESRI formats to Oracle as SDE binary or Oracle Spatial formats
- Easily output the result of ESRI Geoprocessing operations directly to SDE or Oracle Spatial
- Managing data held in Oracle using Oracle clients and viewing the data using ESRI clients is easy
- Managing data held in Oracle using ESRI clients and viewing the data using Oracle clients is easy



# ESRI/Oracle Interoperability

## What is difficult?

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- True integration
- ESRI and Oracle use different mechanisms to constrain data (Tables vs ESRI Domains)
- Editing of geometries held in Oracle Spatial was a problem due to ESRI versioning architecture. At 9.2 it is now possible to do non-versioned editing on layers
- Views can be registered with SDE but not with the Geodatabase this means that views cannot be used with ESRI domains, subtypes, relationship classes etc.
- Managing and editing data using Oracle clients and ESRI clients at the same time



# ESRI/Oracle Interoperability

## What is difficult?

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- There are structural differences between the way GIS and relational systems are designed
- GIS developers tend to have a relatively 'FLAT' object based view and consider layers containing features (a homogeneous collection of objects that have a geometry and a set of attributes). Rarely would the attributes be split into a set of related tables. Separate tables would of course be used when 1:M or M:M relationships are needed
- RDBMS developers not surprisingly take a relational view and split data up into many more tables to create a more normalised structure



# Why Oracle spatial

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- The advantages of a database approach
- Spatial component is inside the database and not middleware
- Oracle Spatial is considered mature, reliable and a functionality-rich product
- Few data modelling restrictions
- Seamless integration with other Oracle products
- To standardise formats to make sharing possible
- Centralise for easy access by all parties
- Provide in generic form also for non-specialist GIS staff



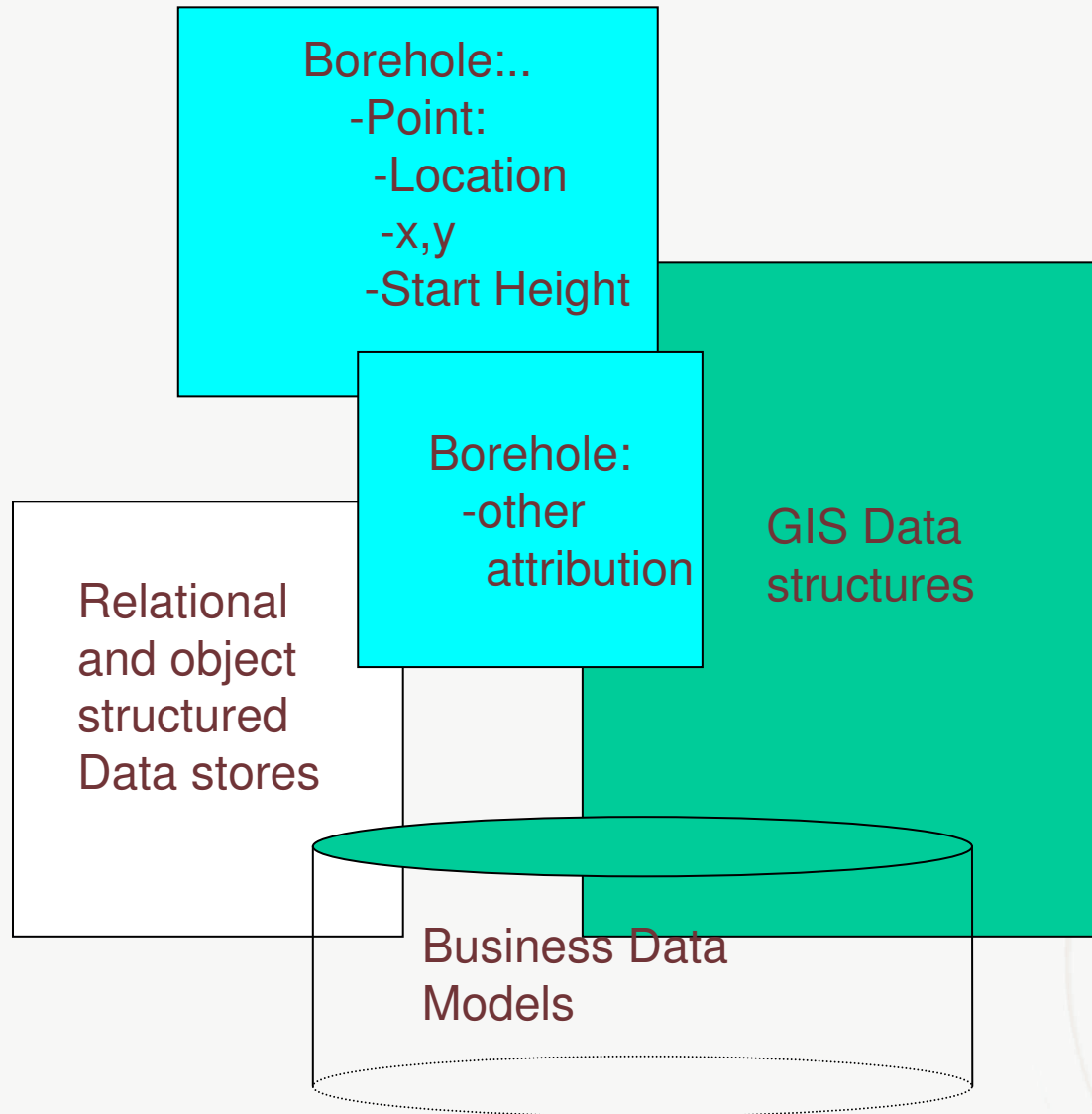
# Role of Spatial Database Technology

- Spatially enabled databases should improve (that is the expectation):
  - Uniqueness and security
  - Speed
  - Spatial queries on structured data
  - Structured queries on spatial data
  - Effective data management
  - Enable alternate access views



# Borehole Data - Example

[www.bgs.ac.uk](http://www.bgs.ac.uk)





# Methods used to spatially enable Oracle tables

[www.bgs.ac.uk](http://www.bgs.ac.uk)

- Adding a Geometry field directly to existing tables where this would not break any existing applications. Geometry column maintained by trigger
- Creating a new table (geometry table) consisting of a geometry field and a unique identifier that can be related to an existing table via a view or materialised view. Geometry maintained by a trigger or a batch process
- Using geometry function and function based index to create a view where read only access is required. No need for a trigger to maintain a separate geometry field as this is created on the fly using a function



### Borehole

BGS\_ID        Number(38) PK  
Bore\_Name    Varchar2(100),  
X             Number,  
Y             Number,  
EPSG\_code    Varchar2(10)  
Drilled\_Length Number(7,2)  
.....

### BOREHOLE GEOM

BGS\_ID        Number(38) PK  
BNG\_Shape    MDSYS.SDO\_GEOMETRY

Create materialised view borehole\_geom\_mv1 or view

```
select rownum OBJECTID, s.bgs_id, s.x, s.y,  
s.bore_name, s.drilled_length, sp.shape  
from sobi s, sobi_sp sp  
where s.bgs_id = sp.fid and  
sp.shape is not null;
```

### Borehole Geom MV1

Object\_Id     Number PK  
BGS\_ID        Number(38)  
Bore\_Name     Varchar2(20)  
X             Number,  
Y             Number,  
EPSG\_code  
Drilled\_Length Number(7,2)  
.....  
BNG\_Shape    MDSYS.SDO\_GEOMETRY

ESRI  
ArcMap  
ArcCatalog  
....

Registering the Materialised view as a layer in ArcSDE  
sdelay -o register -e pn -C id,user -I RGDATA,shape  
-i 5150 -s kwdbase -u bgs -p password



# Spatially enabling an existing table

## Adding a geometry column

www.bgs.ac.uk

*-- add geometry column to existing table*

```
ALTER TABLE RGDATA ADD SHAPE MDSYS.SDO_GEOMETRY;
```

*-- insert metadata for the table with new column*

```
INSERT INTO USER_SDO_GEOM_METADATA VALUES (  
'RGDATA', 'SHAPE', MDSYS.SDO_DIM_ARRAY(  
MDSYS.SDO_DIM_ELEMENT('X', -9, 2, 10),  
MDSYS.SDO_DIM_ELEMENT('Y', 49, 61, 10)), 4277);
```

*-- Update table to populate geometry column*

```
UPDATE RGDATA SET SHAPE =  
MDSYS.SDO_GEOMETRY(2001,4277,MDSYS.SDO_POINT_TYPE(LONGIT  
UDE,LATITUDE,NULL),NULL,NULL);
```

*-- create spatial index*

```
CREATE INDEX RGDATA_SI ON RGDATA(SHAPE) INDEXTYPE IS  
MDSYS.SPATIAL_INDEX;
```

*-- registering the table as a layer in ArcSDE*

```
sdelay -o register -e pn -C id,user -l RGDATA,shape -i 5150 -s kwdbase -u  
bgs -p password
```



# Spatially enabling a table using a function and function based index

## ---- create function

```
create or replace function get_long_lat_pt(longitude in number,  
latitude in number)  
return MDSYS.SDO_GEOMETRY deterministic is  
begin  
return mdsys.sdo_geometry(2001, 8307,  
mdsys.sdo_point_type(longitude, latitude, NULL),NULL, NULL);  
end;
```

## --- Insert metadata for the function

```
insert into user_sdo_geom_metadata values('RGDATA',  
'BGS.get_long_lat_pt(longitude,latitude)',  
mdsys.sdo_dim_array(mdsys.sdo_dim_element('Longitude', -9, 2,  
10), mdsys.sdo_dim_element('Latitude', 49, 61, 10)), 8307);
```

## --- create function based index

```
create index RGDATA_SI on  
RGDATA(get_long_lat_pt(longitude,latitude)) indextype is  
mdsys.spatial_index;
```



# Spatially enabling a table using a function and function based index

www.bgs.ac.uk

*-- create a view that uses the index*

```
create view RGVIEW as select id, latitude, longitude,  
get_long_lat_pt(longitude,latitude) SHAPE from RGDATA;
```

*-- insert metadata for the view or other object*

```
insert into user_sdo_geom_metadata values  
('RGVIEW','SHAPE',  
mdsys.sdo_dim_array(mdsys.sdo_dim_element('Longitude'  
, -9, 2, 10), mdsys.sdo_dim_element('Latitude', 49, 61, 10)),  
8307);
```

*-- Register the view as a layer in ArcSDE*

```
sdelayer -o register -e pn -C id,user -I RGVIEW,shape -i  
5150 -s kwdbase -u BGS -p password
```



# Spatially enabling a table using a separate geometry table

www.bgs.ac.uk

-- create geometry table

```
create table SOBI_SP (bgs_id number(38) not null, bng_shape  
MDSYS.sdo_geometry);
```

-- insert data into table using X, Y from source table

```
insert into SOBI_SP  
select bgsid,mdsys.sdo_geometry(2001, 27700,  
MDSYS.SDO_POINT_TYPE(bng_easting, bng_northing, NULL),  
NULL, NULL) from sobi  
where bng_easting is not null and bng_northing is not null;
```

-- create view or materialised view

Create view or materialised view of the base & geometry tables;

-- insert metadata for table & view or materialised view

```
insert into user_sdo_geom_metadata values ('SOBI_SP','SHAPE',  
mdsys.sdo_dim_array(mdsys.sdo_dim_element('bng_easting', -100000, 800000, 0.5),  
mdsys.sdo_dim_element('bng_northing', -100000, 1400000, 0.5)), 27700);
```

-- Register objects as layers in ArcSDE

```
sdelayer -o register -e pn -C bgs_id,user -l SOBI_SP, shape -i 5150 -s  
kwdbase -u BGS -p password
```



# Mechanisms used for updating geometry

[www.bgs.ac.uk](http://www.bgs.ac.uk)

- Use a trigger to maintain the geometry based on the location attributes entered (e.g. Eastings and Northings)

## PL/SQL Triggers & Procedures

to translate classic data  
into spatial format.

Triggers, procedures in oracle jobs,  
materialised views keep the spatial data in-sync  
with the classic data, in real-time and/or on call.

- Use a batch process to update the geometry at a specified interval e.g. every night
- No mechanism required when functions and function based indexes are used



# Best of the RDBMS and GIS Worlds

[www.bgs.ac.uk](http://www.bgs.ac.uk)

- Unique and secure master location of all data
- Structured query on spatial data
- Spatial query on structured data
- Enable alternative access views
- Server spatial processing (rather than client side)
- Effective data management





# Can Oracle Spatial Help unify RDBMS and GIS?

[www.bgs.ac.uk](http://www.bgs.ac.uk)

- Yes to an extent, but there are as still technological and cultural hurdles to overcome before we can reach the goal of deep integration between GIS and RDBMS systems and between GIS and RDBMS developers
- Oracle Spatial can certainly be effectively used to spatially enable our data that is currently managed by Oracle and Oracle clients
- In the future we would like to be able to have one central data store and a set of diverse applications capable of directly using that data store with a deep level of integration

