



**British  
Geological Survey**

NATURAL ENVIRONMENT RESEARCH COUNCIL

# User Guide Vitrinite Reflectance data

Open Report OR/14/055



# User Guide for Vitrinite Reflectance data

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# Summary

This report describes the vitrinite reflectance point data. The method used to create the dataset has been critically assessed and its fitness for purpose determined by specialists at BGS.

# Acknowledgements

A number of individuals in the Environmental Modelling and Energy Programmes have contributed to the project and helped compile this report. This assistance has been received at all stages of the study. In addition to the collection and processing of data, many individuals have freely given their advice, and provided the local knowledge.

# 1 Introduction

Founded in 1835, the British Geological Survey (BGS) is the world's oldest national geological survey and the United Kingdom's premier centre for earth science information and expertise. The BGS provides expert services and impartial advice in all areas of geoscience. Our client base is drawn from the public and private sectors both in the UK and internationally.

Our innovative digital data products aim to help describe the ground surface and what's beneath across the whole of Great Britain. These digital products are based on the outputs of the BGS survey and research programmes and our substantial national data holdings. This data coupled with our in-house Geoscientific knowledge are combined to provide products relevant to a wide range of users in central and local government, insurance and housing industry, engineering and environmental business, and the British public.

Further information on all the digital data provided by the BGS can be found on our website at <http://www.bgs.ac.uk/data/digitaldata/digitaldata.cfm> or by contacting:

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## 2 About the Vitrinite Reflectance Dataset

### 2.1 BACKGROUND

The UK has abundant shale at depth, although the distribution is not well known. The BGS is investigating the location, depth and properties of the shale as well as the processes that lead to economic accumulations of gas.

BGS has produced a review dataset, based on existing published analyse. The data has been compiled as part of ongoing research of shale gas basins through the use of conventional oil and gas well data to identify potential targets; for example, vitrinite reflectance of organic material within potential shale gas and oil source rocks.

This dataset represents the data gathered for this purpose and provides information on the content and variation within prospective some shale units. Characteristics which are a function of the original depositional setting, subsequent geological history and mineralogy are used to infer the possible presence of shale gas. A number of factors are considered in determining the quality of a source rock including:

- total organic carbon (TOC)
- net to gross organic-rich shale thicknesses
- kerogen type
- thermal maturity\*
- porosity and transport properties
- fracture properties

\* Vitrinite reflectance (VR) is a recognised as a method for the evaluation of thermal maturation

The British Geological Survey has an ongoing development programme to produce datasets that inform and support research. A suite of energy related datasets are currently under development and these are complimented by existing BGS assets.

The data has been generated to provide an overview of VR values from shale rich horizons obtained from analysis of boreholes drilled across Great Britain. It has been derived from publications of analyses of organic-rich shale samples from BGS (formerly IGS) boreholes. Related products:

- DiGMapGB - digital geological data bedrock and superficial at a range of scales
- Scans of onshore borehole logs for Great Britain
- Scans of geology and historic topography maps
- Aquifer, shale and clay maps  
(<http://www.bgs.ac.uk/research/groundwater/shaleGas/aquifersAndShales/maps/home.html>)
- 3d models and cross-sections
- Total Organic Content

## 2.2 WHO MIGHT REQUIRE THIS DATA?

- Hydrocarbon exploration companies
- Hydrocarbon service companies
- Central government
- Academics

The vitrinite reflectance (VR) data provides VR values from shale-rich horizons identified in boreholes drilled across Great Britain. The data along with other energy data may be of interest to exploration companies and academics.

## 2.3 WHAT THE DATASET SHOWS?

Vitrinite reflectance is an evaluation method for thermal maturity of a source rock. Vitrinite is a maceral (a component, organic in origin, of coal or oil shale) which is formed through the alteration of lignin and cellulose in plant cell walls. The reflectivity of vitrinite macerals increase in response to thermal alteration and is used to define maturity levels and by projection to predict maturity at depth. Rocks buried at depth are subject to higher temperatures and as this increases vitrinite is altered through a process known as aromatization which increase the reflective properties.

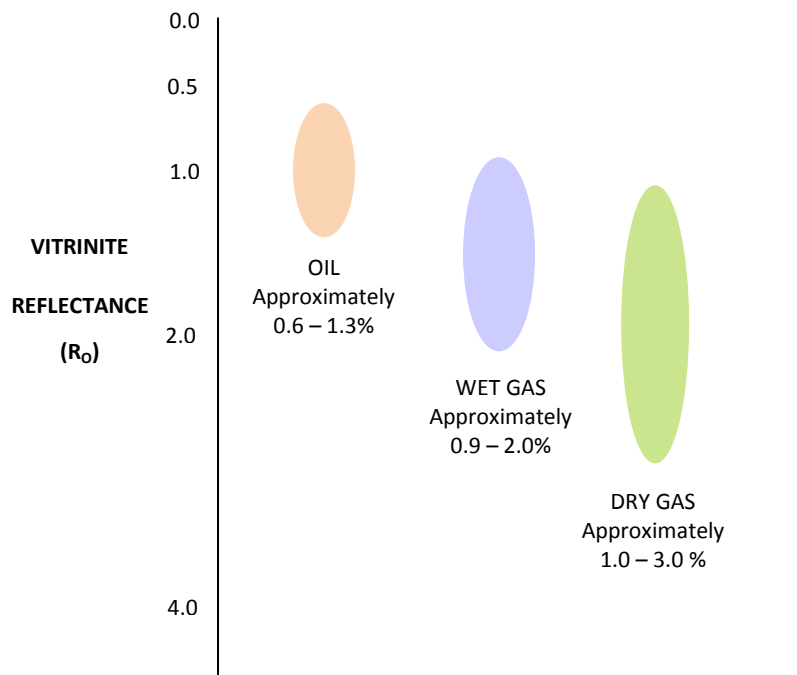
Vitrinite reflectance is measured using a reflectance microscope and results recorded in terms of Reflectivity (R) representing the percentage of light reflected in oil known as  $R_o$ .

# 3 Technical Information

## 3.1 DEFINITIONS

**Vitrinite reflectance** - a method for identifying the maximum temperature history of sediments in sedimentary basins and in the context of this dataset an indicator of potential hydrocarbon resources. VR can be calibrated to indicate the maturity of hydrocarbon source rocks and indicates whether a rock has been heated enough to produce oil, oil and gas or gas only, Figure 1 gives a schematic illustration of this.





**Figure 1 Vitrinite reflectance (Ro) values indicating hydrocarbon type**

(based on droplet diagram first presented by W.Dow in the Journal of Geochemical Exploration 1977)

Vitrinite reflectance measures the percentage of incident light reflected from a polished surface of vitrinite and is presented in units %Ro, the measured percentage of reflected light from a sample which is immersed in oil (%Ro = % reflectance in oil).

**Maturity** is described in four classes based on the vitrinite reflectance:

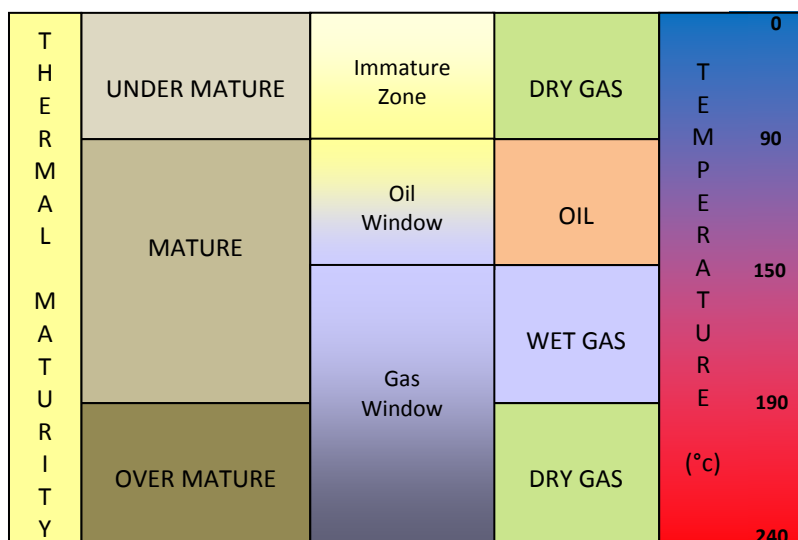
Under mature – source rocks have not yet been exposed to sufficient heat for thermal generation of oil or gas.

Oil window - onset of oil generation is correlated with VR of 0.5-0.6 %  $R_0$  and termination of oil generation between 0.85-1.1 %  $R_0$ .

Gas window-onset of the gas window is associated with values of 1.0-1.3%  $R_0$  and terminates around 3.0%  $R_0$

Over mature – spent rocks which have entered the gas window and have already generated oil or gas and as a result are depleted and have therefore exhausted all hydrogen necessary for further oil or gas generation.

It should be noted that these generation windows vary between different source rocks and with different kerogens (mixtures or organic chemical compounds). The temperature ranges associated with the vitrinite reflectance values are indicated in Figure 2.



**Figure 2 Maturity zones**

### 3.2 SCALE

The vitrinite reflectance data is produced as point data from boreholes whose locations are given to the nearest 10 metres, identified by an easting and northing. The depth at which samples were taken for analysis is recorded to two decimal places.

### 3.3 FIELD DESCRIPTIONS

**Table 1 Attribute table field descriptions**

FIELD NAME	FIELD TYPE	DESCRIPTION
WID	String	Well identification number
WELL_NAME	String	Nationally registered well name in the BGS Borehole database SOBI (Single Onshore Borehole Index)
EASTING	Long	Six figure national grid reference
NORTHING	Long	Six figure national grid reference
DEPTH	Float	Depth in meters at which the sample was taken
VR	Float	Vitrinite Reflectance value (%) represents the level of maturity of the source rock sample
MATURITY	String	Level of maturity of the potential source rock; four categories identified: under mature, over mature, oil window, gas window
LEX_CODE	String	Formation level <a href="#">BGS lexicon</a> code for rock sample used.
LEX_DESC	String	Rock description as provided in the <a href="#">BGS lexicon</a>
VERSION	String	Version of data, updated when revisions to data take place.

### 3.4 CREATION OF THE DATASET

Boreholes for which vitrinite reflectance analyses have been carried out were identified in the Single Onshore Borehole Index (SOBI). These locations along with their VR data were extracted and are contained in the accompanying dataset.

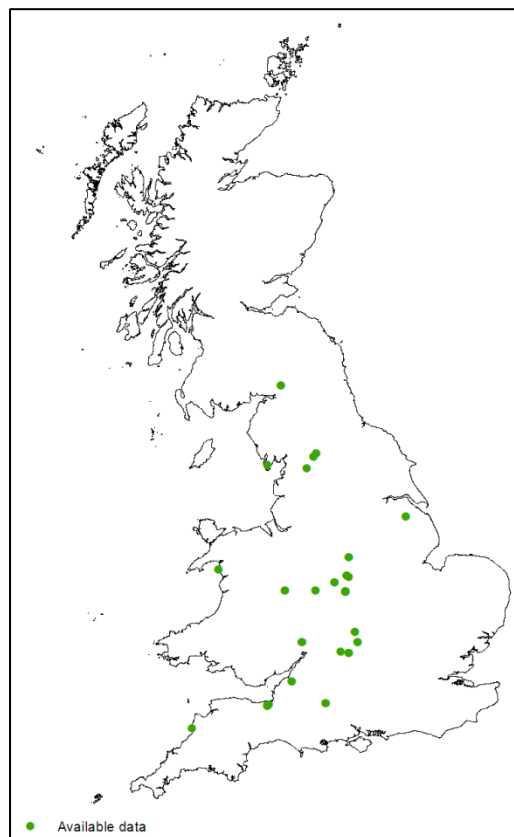
### 3.5 DATASET HISTORY

The British Geological Survey has been carrying out basin analysis and unconventional hydrocarbon research. This dataset draws on the interpretations gathered during this research and provides the first access to the vitrinite reflectance data held by BGS.

BGS is committed to ongoing development of its data products and it is expected that this dataset will continue to develop and that further boreholes and interpretations will be included in later versions.

### 3.6 COVERAGE

Data coverage is currently sparse; data distribution is based on boreholes which have interpreted and has measurable vitrinite reflectance.



**Figure 3 Data coverage of vitrinite reflectance**

### 3.7 DATA FORMAT

The vitrinite reflectance dataset has been created as asset of point locations (easting and northing) and are available in a range of GIS formats, including ArcGIS (.shp), ArcInfo Coverages and MapInfo (.tab). More specialised formats may be available but may incur additional processing costs.

### 3.8 LIMITATIONS

The Vitrinite Reflectance dataset is produced as point data from a number of strategic boreholes whose location is given to the nearest 10 metres.

The VR data is based on, and limited to, an interpretation of the records in possession of the British Geological Survey at the time the data was released.

A high VR value is not necessarily an indicator of shale gas or oil potential. Other factors such as total organic content must be assessed.

Vitrinite reflectance has been created as a set of point data, and is available in a range of GIS formats, including ArcGIS (.shp), ArcInfo Coverages and MapInfo (.tab). More specialised formats may be available but may incur additional processing costs.

## 4 Licensing Information

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