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A revised scheme for coding unlithified deposits (also applicable to engineering soils)

National Geoscience Framework Programme

Internal Report IR/05/123

BRITISH GEOLOGICAL SURVEY

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A revised scheme for coding unlithified deposits (also applicable to engineering soils)

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Keywords

Report; superficial; unlithified, unconsolidated; clay; silt; sand; gravel; cobble; boulder; peat; borehole; code; lithology; nomenclature.

Front cover

Glacial till from the Crockey Hill Borehole (SE64NW293, 463621 445504) depth 3.8-3.9m. Width of sample 10cm. Lithology CLAY, gravelly, sandy; code CVS

Bibliographical reference

COOPER, A H, KESSLER, H & FORD, J. 2006. A revised scheme for coding unlithified deposits (also applicable to engineering soils) . *British Geological Survey Internal Report*, IR/05/123. 45pp.

Keyworth, Nottingham British Geological Survey 2006

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Foreword

This report is the product of a study by the British Geological Survey (BGS) as part of the resurvey of the Vale of York (Selby sheet 71) project codes ESB72900133 (up to 2003) and E1276S72 (from April 2003). The work was also supported by the SDAG (Superficial Deposits Advisory Group), and the UGGH (Urban Geoscience and Geological Hazards Programme). The work was completed under the auspices of the National Geoscience Framework Programme E2004S77/03 (Rock classification) project.

The work has resulted in computer codes for unlithified deposits (also referred to as superficial deposits and as “engineering soils”). The list of codes are available over the internet on the BGS web pages

http://www.bgs.ac.uk/bgsrcs/searchRCS.html where the codes and descriptions are currently designated the Unconsolidated Deposits Classification Scheme.

Acknowledgements

This work has benefited from numerous discussions with many colleagues in the British Geological Survey. In particular, the support and encouragement of SDAG (Superficial Deposits Advisory Group) chaired by Andrew McMillan and the support of Professor Martin Culshaw of UGGH (Urban Geoscience and Geological Hazards) are acknowledged. Mr Poul Strange is thanked for his support, which has enabled the scheme to be introduced on the mapping and borehole coding undertaken for the Vale of York resurveying.

Dr Dave Lowe is thanked for his advice on the stratigraphical lexicon and the rock classification scheme. Mr Jeremy Giles is thanked for discussions about the constraints on the computer coding within BGS. Alan Forster, Kevin Northmore, Dave Entwisle and Sue Self are thanked for useful discussions about the use of computer codes in Engineering Geology. Helen Balson is thanked for discussions about the use of computer codes for lithology in coastal geology. Antony Benham, Dick Crofts and Dave Entwisle are thanked for critically reviewing the report and the scheme; Dr Mike Styles, Dr Graham Lott and Dr Peter Balson are thanked for their comments. Dr Andy Howard is thanked for his support to complete the project and for discussion about the implementation of the scheme into the SIGMA workflow, field data capture and GSI3D system.

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Summary

This report details the reasoning and methodology for the introduction of a revised computer-coding scheme for unlithified deposits, commonly also referred to as superficial deposits, unconsolidated deposits or engineering soils. These include clay, silt, sand, gravel, cobbles, boulders and peat plus all the combinations of these deposits. The report describes the former BGS system for coding such deposits and details a logical system for coding many hundreds of lithological mixtures by the simple use of up to seven letters in various combinations.

The scheme is designed to be universal in its application and usable for historical and modern geological information including field data capture. It is not a classification scheme, but a coding scheme, furthermore it is not intended as a replacement for a full lithological description. The report details the implications on this coding scheme of using BS5930 and the AGS (Association of Geotechnical and Geoenvironmental Specialists) borehole recording classifications. It also details how the coding scheme can be applied to other classification schemes including IMAU (Industrial Mineral Assessment Unit) and material recorded by offshore and coastal studies. All these schemes differ in the way they subdivide and group lithologies, they also vary slightly in the grain size classifications they use. However, most of the differences are slight and fall within the variation of the accuracy of field recording by whichever method.

The report presents an abridged listing of the proposed codes based on the most commonly encountered combinations and the lithological ornament fields currently used in AGS borehole packages. However, others may need to be added to make the scheme comprehensive. If all the combinations of codes are taken into account there are 8660 different codes, but the introduction of so many variables would make the system unwieldy.

The report also lists a much simplified set of codes for colouring borehole sections and maps using GIS and borehole viewing software where it is desirable to have the detail in the borehole logs, but generalisation is needed for correlation and presentation.

1 Introduction

1.1 BACKGROUND

BGS uses coding schemes to allow the controlled entry of unlithified deposits and solid rock data into BGS databases. They are used for recording information from boreholes, samples, outcrops and maps. The coding schemes for lithology are included in the BGS Rock Classification Scheme (RCS http://www.bgs.ac.uk/bgsrcs/searchRCS.html). These have recently been considerably revised especially for the classification of igneous and sedimentary rocks. However, fewer improvements were made to the coding of unlithified deposits. In order to make a modern usable scheme that fits with the civil engineering industry usage (BS5930) and the digital borehole data coming into BGS (AGS data) a more comprehensive scheme is required. The proposed scheme has already been widely used for BGS commercial projects. It must be stressed that it is a coding scheme not a classification scheme; furthermore it is not intended, and must not be used, as a replacement for a full lithological description. This report presents here the scheme and gives the background information that constrained the way it has been constructed. It also presents a generalised list of codes.

1.2 THE FORMER BGS SCHEME AND NEED FOR A NEW ONE

Since the earliest BGS databases, such as BLITH (Borehole Lithology), the attribution of unlithified deposits has been based on codes that were implemented as required. Consequently the system grew in an ad hoc way starting with codes such as CLAY for clay and SAND for sand, SAGR for sand and gravel etc. As the requirement grew for more detailed attribution for borehole coding, new codes continued to be added in a piecemeal way resulting in codes such as CLYGV for clayey gravel, SISND for silty sand, GVSLTY for silty gravel and ORCL for organic clay. These codes were not consistent, they were difficult to remember and covered only a limited number of lithologies. Other codes, for example DMTN (diamicton) were introduced and applied widely to glacial till (boulder clay) and head, both deposits that could range from clayey sand with gravel to clay with gravel. Such terms were insufficiently precise, especially for engineering purposes and hydrogeological modelling. There was a need for a comprehensive scheme of codes structured in a way to make them easy to search or use in a database or GIS.

In addition to the main lithological codes, there were several other databases within BGS that used different coding schemes. These included the Engineering Geology Database and the LOIS database. Furthermore, the standards for civil engineering logging (BS5930) placed constraints on the way boreholes were logged and thus the type of data that was being collected by the corporate BGS data holdings. Another external constraint on the supply of data is the AGS (Association of Geotechnical Specialists) and independent software houses that use their scheme. The implementation of a comprehensive and possibly universal coding scheme has the potential for much easier data exchange both within BGS and outside. It makes possible the use of industry borehole data in its original form and because it is hierarchical it allows the simple grouping of data or colouring of information on cross-sections and GIS screens. The lithological codes form the basis for producing 3D geological models using the GSI3D (Geological Surveying and Investigation in 3D) modelling package.

1.3 THE ENGINEERING GEOLOGY DATABASE SCHEME

The BGS Engineering Geology database used a system that is very similar to that described here. It listed lithology in order of decreasing importance using individual letters for each major lithology and upper or lower case characters to help determine amounts. This scheme has the advantage of allowing more resolution of detail, but the implementation of codes via Oracle RDBMS (Relational DataBase Management System) and other means currently requires them all to be in upper case.

1.4 BGS ROCK CLASSIFICATION SCHEME: SEDIMENTS AND SEDIMENTARY ROCKS

The scheme by Hallsworth and Knox (1999) is the foundation of the BGS Rock Classification Scheme. It is very comprehensive for sedimentary rocks, but places lesser emphasis on the unlithified materials, though it does present both together. The scheme is based first on mineral content and secondly on grain size, but does not deal comprehensively with mixed materials. It classes many of the mixed materials as diamicton with an indication that they can be subdivided into sandy diamicton and clayey diamicton. Only diamicton and chalky diamicton are listed on the internet RCS. The scheme "*requires all root names based on grain size to be clarified by reference to clast composition". "They are primarily subdivided into gravels, sands and muds, and the grain size is prefixed with a reference to their composition. For example a sediment consisting of sand-grade lime clasts is given the root name lime-sand. To prevent any confusion, sediments composed of silicate particles should also include the prefix silicate-in the root name for example silicate-sand."* The RCS therefore enables unusual mineral sands to be coded, but the majority of the borehole information in the BGS archives and coming into BGS from outside does not specify the mineralogical content of the material. The RCS

does not have codes for many of the common mixed materials that are described in many of site investigations.

1.5 THE BGS ROCK CLASSIFICATION SCHEME: ARTIFICIAL (MAN MADE) GROUND AND NATURAL SUPERFICIAL DEPOSITS

This report by McMillan and Powell (1999) is in the same series as the Hallsworth and Knox (1999) report. It reviews numerous classification schemes and their usage in BGS. In table 5 (page 33) it presents a short list of lithologies which are ones that largely exist in the former BGS (BLITH) offshore and onshore computer codes. They do not present a scheme that can deal with the wide range of lithological mixtures that are recorded on engineering geology logs.

1.6 THE LOIS SCHEME

The LOIS (Land Ocean Interaction Study) project used a system similar to that proposed here, but it mixes letter codes for individual components with letter codes for mixed lithologies. For the Humber Estuary, this dataset was successfully converted into the new scheme presented here for modelling using the GSI3D.

1.7 THE AGS SYSTEM

The AGS (Association of Geotechnical and Geoenvironmental Specialists) has published standards (1999) for the electronic transfer of data. It does not include dictionaries in that specification, but several of the companies using that format have their own including Howland Associates, Geodasy system. BGS has a copy of the Howland AGS software and there are numerous numeric codes that equate with the lithological ornament to be added to the logs. Other companies use a different way of ornamenting their logs. From discussions, it is apparent that the AGS would prefer a unified system at least to control the ornament of the lithological blocks. They currently refer to the BGS web sites for rock and stratigraphical codes, but make their use voluntary.

1.8 BS5930 (1999)

The British Standard BS5930 (British Standards Institution, 1999) defines the way that superficial deposits are to be described for engineering purposes. It presents a complicated set of parameters that allow the full description of superficial deposits ranging from clays to boulders and any mixture thereof. There are some differences from the way BGS currently describes some of the entities, but basically all engineering logs coming to BGS will use this system and electronically recorded information in AGS format conforms to this standard. Many projects in BGS are now adopting BS5930:1999 as their logging standard for boreholes and field information.

Because BS5930 is designed for engineering use and field description some of the subdivisions are “biased” towards the engineering properties of the materials. Consequently, a deposit that is sandy clay may contain up to 65% sand not 50% sand as might be expected. This is because the clay fraction coats the sand and for engineering purposes the deposit behaves more like a clay. Dominantly clay and dominantly silt lithologies behave differently in engineering and they are separated by where they plot on a plasticity chart. Deposits are described as Clay or Silt dependent on their engineering properties, not precisely on their percentages of Clay or Silt. Clay/Silt is allowed, but rarely used in modern BS5930 descriptions. A number of field tests are used to separate clay and silt in BS5930 (British Standards Institution, 1999).

1.9 BS5930 (1981)

There is also an older version of BS5930 dating from 1981 and used up to 1999. Boreholes logged to that standard between those years have a subtle difference in the way that certain lithologies have been recorded. Logs prior to 1999 allowed the use of the term silty clay, whereas post 1999 the terms silt and clay are intended to be used in a mutually exclusive way based on the field characteristics of the material.

1.10 BS5930 AND WENTWORTH DIFFERENCES

It is imperative that the schemes used for grain size classification and other descriptive parameters are referenced. Records should state if they conform to BS5930 (British Standards Institution, 1999) or if they relate to the Wentworth grain size classification scheme if that is used (Wentworth, 1922).

There are minor differences in the grain size groupings between BS5930 and the Wentworth Scheme (Figure 1). However, the differences are mainly in the subdivisions of the sand with BS5930 breaking sand into three subdivisions and Wentworth into five. Sand in BS5930 ranges from 0.06mm to 2mm, sand in Wentworth ranges from 0.0625mm to 2mm. For practical purposes, sand is the same in both and this is important for the way our scheme is implemented. There are similar minor differences between the ranges for silt and clay. Silt in BS5930 is 0.002mm to 0.06mm while in Wentworth it is 0.0039mm to 0.0625mm. Similarly clay ranges up to 0.002mm in BS5930, but 0.0039mm in Wentworth. These very small differences can only be determined by very accurate laboratory examination, in which case full grading curves would be available. For field use and for the majority of borehole and sample information coming into BGS, these differences cannot be differentiated.

The BGS unlithified deposits coding scheme does not deal with the details of attributes such as the sand grain sizes of fine, medium and coarse (BS5930) or the five sand grain sizes used by Wentworth; they are all coded as sand. Variations in the grain size can only be accounted for in separate attribute tables and these must state which grain size classification scheme has been used.

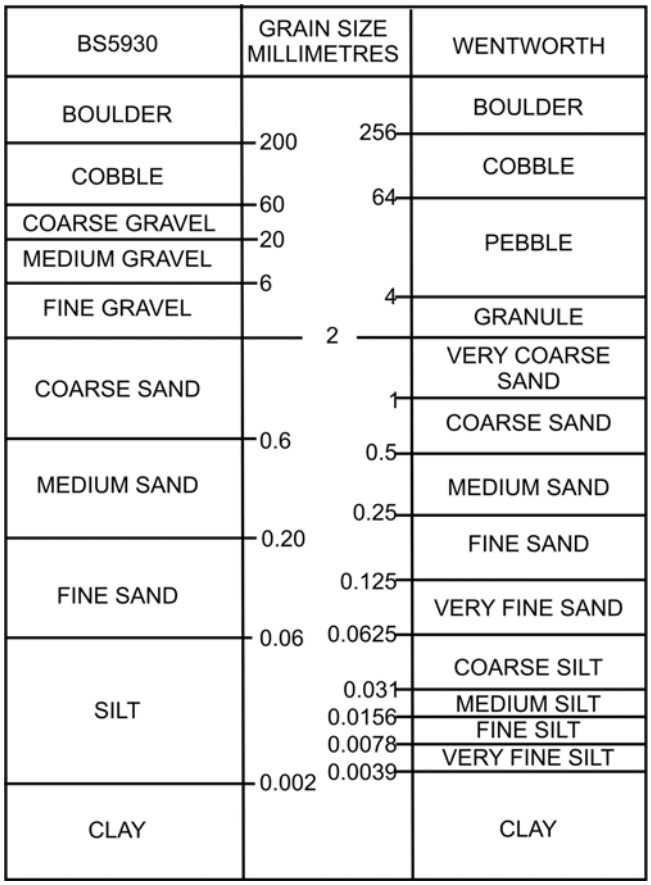


Figure 1 Comparison between BS5930 and Wentworth grain size classification schemes.

1.11 BGS MINERAL ASSESSMENT UNIT (IMAU) GRADINGS

The Mineral Assessment Unit grading scheme was presented in the reports for that project. A triangular diagram (ie Hollyer, 1978 p. 38 – reproduced here as Figure 4) subdivided the sand, gravel and fines (clay and silt) into 12 fields labelled with Roman numerals. In this scheme, based on the needs of the mineral industry, the cross-over from non-mineral to mineral occurs at 40% fines (clay and silt) to 60% sand and gravel. This is considerably different to the cross-over point in the descriptions from the BS5930 scheme. Furthermore, the IMAU grading scheme has the grain size change between sand and gravel (pebble) as 4mm whereas BS5930 and Wentworth both take it at 2mm. It must be recognised that any IMAU borehole in the BGS borehole database has been logged in this manner and that there are small differences in the cross-over size from sand to gravel when compared with the scientific and engineering norms for sample description (Figure 4).

1.12 OFFSHORE SEA BED SEDIMENT MAPS

Another borehole material logging scheme was used for the production of the sea bed sediment maps. These differ from the BS5930 and IMAU classifications mainly by the combining of the silt and clay-sized fractions as ‘Mud’. The grain sizes were classified using the Wentworth Scale, but grouped using the Folk classification (Figure 5).

1.13 HISTORICAL BOREHOLES

The BGS archives hold large amounts of borehole information going back for over 150 years. These holes have been logged by various geologists, drillers and amateurs. Some have also been described using various terms that are now defunct. For the majority of these holes there is doubt about the parameters used to determine the grain size and the description of the overall lithology. However, many are useful boreholes and need to be incorporated into the BGS digital data holdings. The scheme we propose can be applied to such descriptions, but again it should be recorded alongside the data that the source was old archive information.

2 The unlithified deposits coding scheme

2.1 THE CODING SCHEME

BGS requires a coding system that will allow the input of information from engineering and other borehole logs so that it does not change the meaning of the log. We are limited to 6 characters in the RCS code by database design, but fortunately there are 6 end members to the lithologies of the majority of "granular" deposits as described in geology and engineering geology. These are clay, silt, sand, gravel, cobbles and boulders (BS5930 not Wentworth). The engineering geology database, LOIS and soil survey use all use Z to signify silt. In addition, many schemes include peat as a component and we have included this as the seventh code. Consequently, we can designate each lithology with one character and use combinations of characters to describe more complex mixed lithologies. The abbreviations are:

CLAY: C
SILT: Z
SAND: S
GRAVEL: V*
COBBLES: L
BOULDERS: B
PEAT: P

(* V is suggested for gravel because G is extensively used, combined with other letters, in the RCS for Gabbro etc and some of the code combinations generated by the proposed scheme would clash. V has no conflicts).

For ease of use in databases and for searching it is recommended that the dominant lithology (the one that is in capitals in engineering logs) is listed *first* in the code. This practice follows that used for the BGS engineering geology database. The subordinate lithologies are then listed in decreasing order, ie:

BS5930 description	RCS description	CODE
SAND	SAND	S
Clayey SAND	SAND, clayey	SC
Silty SAND	SAND, silty	SZ
Gravelly SAND	SAND, gravelly	SV
Cobbly SAND	SAND, cobbly	SL
Bouldery SAND	SAND, bouldery	SB
Silty clayey SAND	SAND, clayey silty	SCZ
Gravelly clayey SAND	SAND, clayey, gravelly	SCV
Gravelly silty SAND	SAND,silty, gravelly	SZV
Bouldery, cobbly, gravelly, silty, clayey, SAND	SAND, clayey, silty, gravelly, cobbly, bouldery	SCZVLB
And so on		

Figure 2 Some examples of the way the coding scheme works.

It is important to note that the civil engineering practice detailed in BS5930 describes the deposits in increasing order of content ending with the major component in upper case text. This is the opposite to the way the coding works and contrary to the way the BGS RCS scheme is structured. A further complication is that the BS5930 system also allows large grain sized materials to be added to the description after the main lithology (ie. clayey gravelly SAND with some boulders). Such descriptions have to be disentangled to allow the deposits to be correctly coded (the example above would be (SVCB).

This proposed BGS scheme allows all the combinations of lithology currently used in the AGS listings of Howland Associates, plus the BS5930 attributes to be coded (see attached spreadsheet). However, It does not separate the very sandy from the slightly sandy or the very clayey from the slightly clayey as used in BS5930. If required, these attributes could be included in a properties table in one of two ways. A simple way would be to allow a property such as "very clayey sand" or "slightly sandy clay" as a qualifier to the main scheme. A more complicated way would be to use a column for each root lithology and a number to signify very, moderately, slightly and equal amounts organised so that the numbers always add up to 10 and effectively represent percentages.

The scheme does not separate out the fine, medium and coarse elements of the various lithologies, but these are included in the descriptions of the materials and could be included in the properties tables of items such as borehole geology.

It is suggested that the code DMTN could be retained for geological logs where there is no lithological detail and the log just states "boulder clay" or "till" and no proper lithological designation is possible.

The scheme is attached as a spreadsheet in the appendix. The triangular diagrams (Figures 3, 4 and 5) indicate how it fits in with the BS5930 scheme. The spreadsheet also includes various deposits described as peat and peaty. It is suggested that these should also be used to allow for the inclusion of peat deposits that are not well catered for in the present BGS scheme. Their inclusion also allows archival AGS data compiled on Howland Associates software to be ported into the BGS database. A peat in engineering terms is classed as having greater than 70% peat and less than 30% of other materials. Less than 70% peat and the deposit is peaty or organic with qualifiers of slightly, no qualifier or very being applied dependent on the amount of organic matter present. These minor variations cannot be included in the coding scheme, but the position of the P in the code does indicate whether it is a major or minor component.

2.2 LIMITATIONS, PROBLEMS AND SUGGESTIONS ASSOCIATED WITH THE PROPOSED SCHEME

The coding scheme proposed here uses the same codes for materials that have been logged and recorded using numerous methods that differ slightly in the grain size parameters. The various methods differ in the way the lithologies have been subdivided and grouped (compare the triangular diagrams). However, the scheme proposed here has the advantage that it allows boreholes to be coded in a unified way based on the diverse written and graded lithological descriptions. These coded boreholes can then be used in 3D geological modelling software. It is important that the variations in the data are appreciated; they can be checked by reference to the original borehole logs, and should be flagged up during coding (see below). Without an unlithified deposits coding scheme, such as the one described here, it is impossible to use all the borehole data in a consistent way. In practice, no matter which scheme has been used for the description, there is a considerable amount of variability and overlap in the described deposits, especially ones recorded without any laboratory grading and analysis.

Most borehole logging is done visually and percentages are largely estimated without the use of grading charts or the use of sieves and weighing. It is unlikely that many geologists can accurately estimate the difference between a sandy gravel that is 55% gravel (proposed code VS) and a gravelly sand which is 45% gravel (proposed code SV). Consequently, and for consistency, the use of the term Sand and Gravel for a deposit, which is supposedly 50/50% sand and gravel, is best referred to as gravelly sand (proposed code SV).

For consistency, mud used for the offshore grading scheme is best coded as ZC (Silt, clayey) unless grading information shows that it is CZ (Clay, silty). It has been suggested that M could be used instead of CZ or ZC for data gathered using the offshore scheme. However, that would destroy the homogeneity of the proposed scheme and make correlation between the different schemes impossible. Boreholes logged using BS5930 will have had the presence of largely clay, largely silt, and mixed lithologies determined by field examination observations. It is suggested that C (clay) is used for deposits described as clay and Z (silt) for deposits described as silt. In reality it must be recognised that there will most likely be other lithologies mixed in the deposits; most BS5930 field described clays will be CZ (clay and silt) while most silts will be ZC (silt and clay). Older BS5930 logs (pre-1999) include the terms silty clay and clayey silt, but these are discouraged after that date, though many logs still include them.

One way of getting around the potential problems of unifying information into one coding scheme is to add columns of information that define the source standard. There could be a column stating the grain size scheme used to constrain the description (BS5930 visual; BS5930 laboratory; Wentworth visual; Wentworth laboratory; unknown – ie historical, old field descriptions, drillers logs). There could also be a column stating the lithological description scheme (BS5930, 1999; BS5930, 1981; Folk 1954; BGS offshore; IMAU; unknown ie historical, drillers log etc). This information could be gathered in the header fields of Borehole Geology rather than for each entry. The inclusion of such information would allow the dataset to be interrogated in a database or GIS so that it would be obvious if any bias from the logging scheme was locally skewing the results.

There is a computer program by Poppe et al., 2003 which will convert grading percentages into Folk 1954/1974 or Shepard 1954/Schlee 1973 sedimentary descriptions. It would be feasible to utilise a similar program to convert sediment grading percentages into lithological codes.

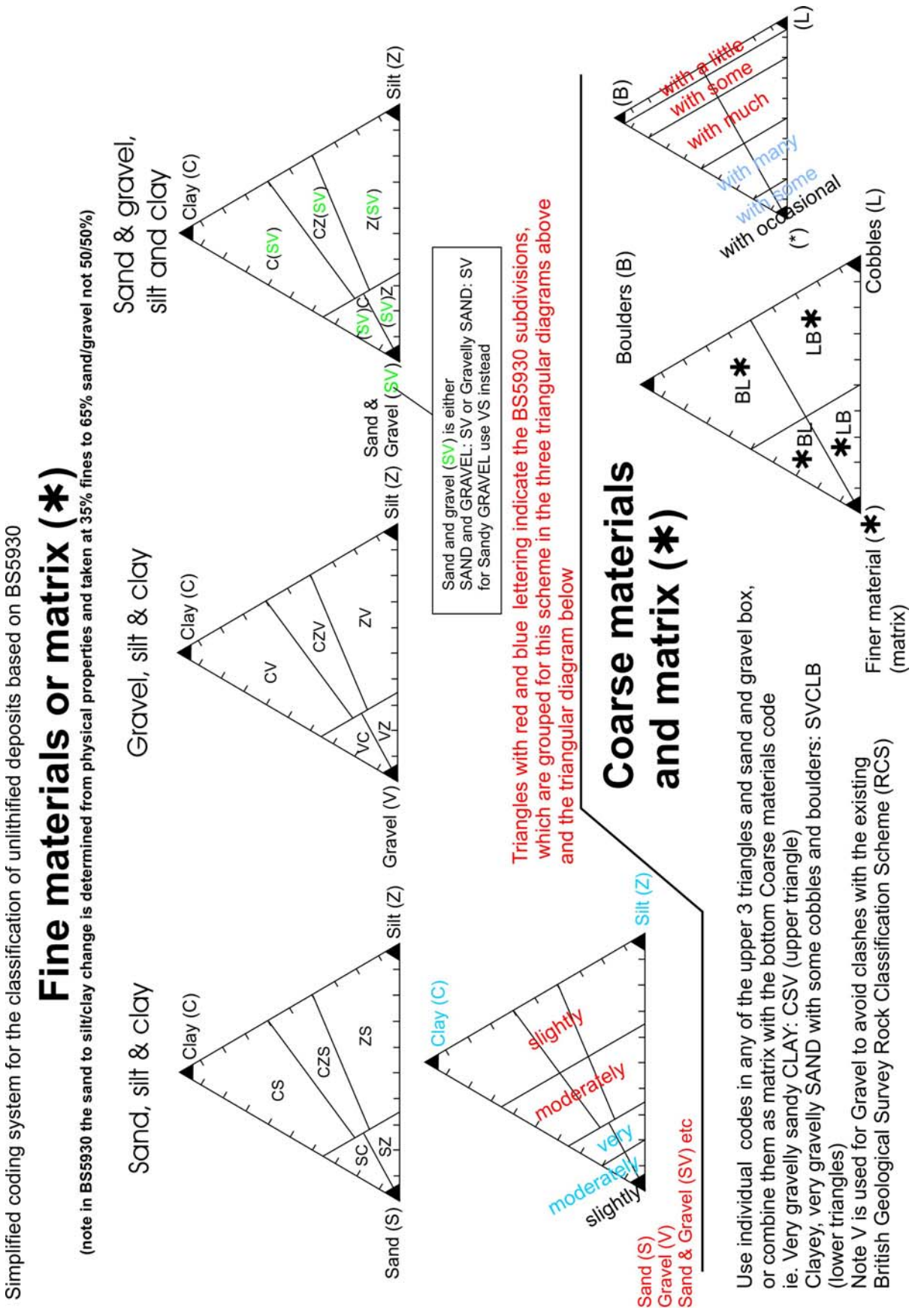


Figure 3 Triangular diagrams, generated from BS5930 classifications, showing the subdivisions of lithologies and the amalgamated fields used for the Unlithified Deposits Coding Scheme. Note that some of the fields shown in red or blue are amalgamated. A deposit that is technically a clayey sand may be determined to be a sandy clay because of its engineering properties.

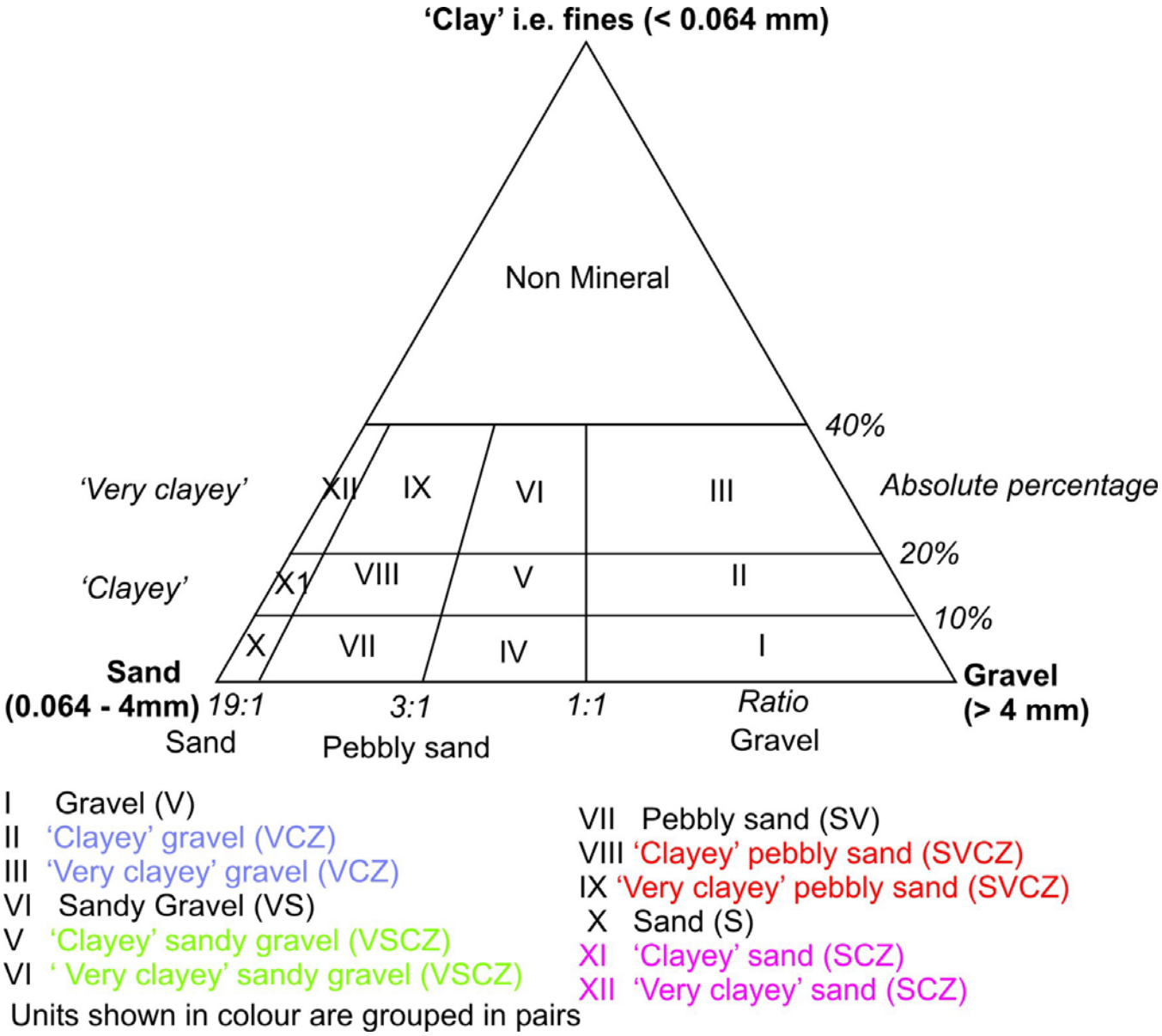


Figure 4 Triangular diagram showing the subdivisions of sand, gravel and fines used for the assessment of sand and gravel by the Industrial Minerals Assessment Unit (IMAU) (Hollyer, 1978). The equivalent codes for the unlithified deposits coding scheme are shown in parentheses and the units that have the same codes are grouped in coloured pairs.

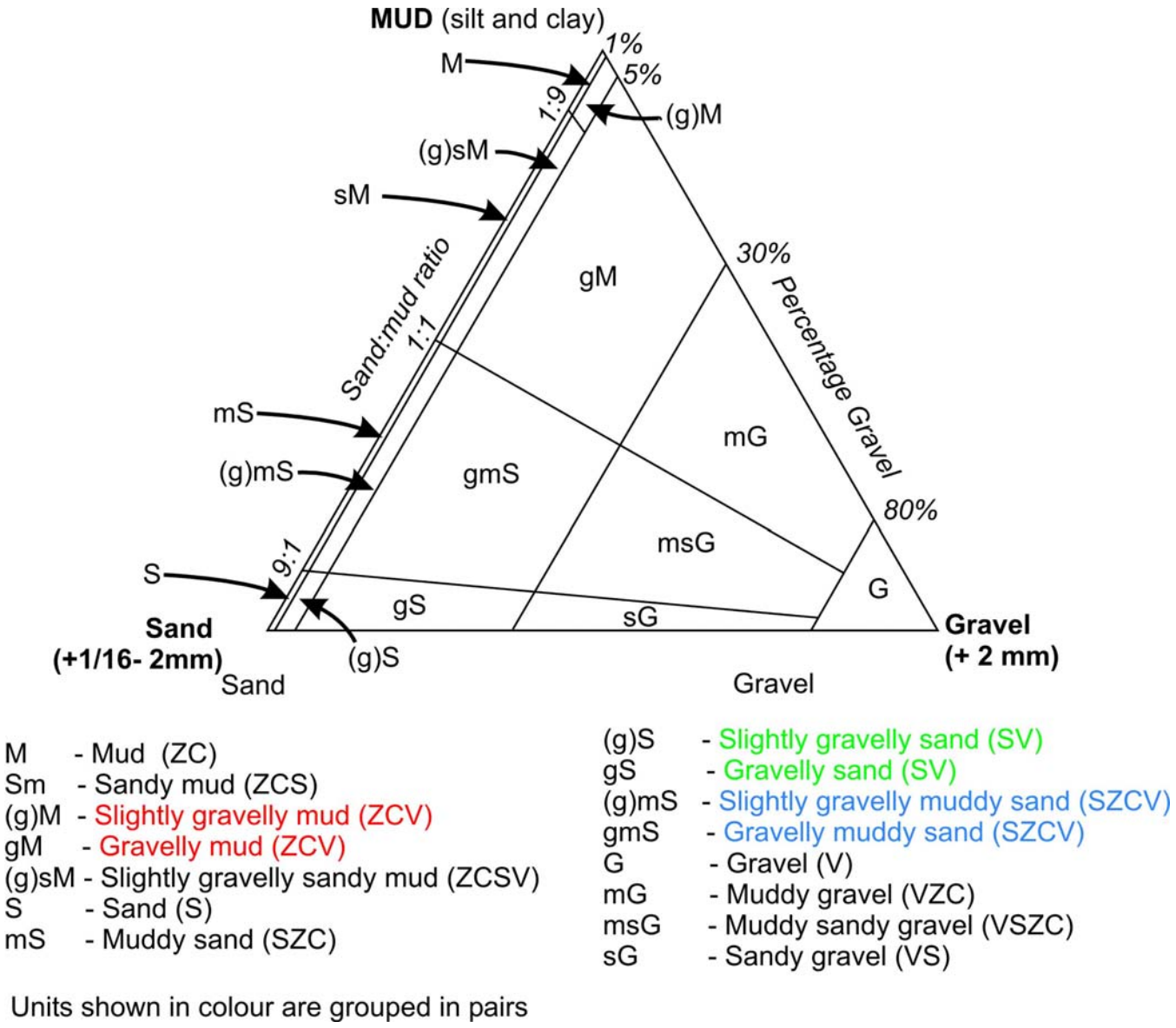


Figure 5 Triangular diagram showing the subdivisions of sand, gravel and mud used for offshore sea bed sediment mapping used on published BGS maps after Folk, 1954. The equivalent codes for the unlithified deposits coding scheme are shown in parentheses and the units that have the same codes are grouped in coloured pairs. Note that mud is translated as ZC.

Note, this BGS scheme differs slightly from Folk (1954) in that he takes the non-gravelly sand to clay percentage as 0.1%, the BGS offshore scheme takes it as 1% as shown above. The diagram has been rotated through 90 degrees to make it compatible with the IMAU diagram on the previous page.

3 Amalgamated, generalised or simple codes for ornamenting and colouring deposits

3.1 RATIONALE

This flexible coding scheme allows the creation of any valid combination of lithological components between 1 and 6 characters in length. This approach provides a comprehensive means of accurately describing a wide range of unlithified deposits. It also provides information for analysing the distribution of deposits and their lithological variation. However, to display the data for visualisation and modelling purposes, including GIS and GSI3D applications, it is necessary to rationalise the comprehensive list of codes into a meaningful subset of lithological classes.

A standard approach for rationalising raw lithology codes is described below together with a corresponding routine for symbolisation. The rationalised codes are shown in bold in appendix 1. A set of tools has been created to automate the rationalisation of raw lithology codes; a worksheet function is available for batch data processing within Microsoft Excel (Appendix 2); a standalone application is available for individual code conversion (Appendix 3).

3.2 SIMPLIFYING THE CODES FOR VISUALISATION AND MODELLING

The approach attempts to maintain the dominant lithological characteristics (taken from the first two characters of the raw code) whilst recording any key indicators such as the existence of coarser material (possibly indicative of till) and peat (for compressibility). For economy, the code for gravel (V) is used to describe all coarse (>S) material outside the first two characters. If coarse material is described in the first two characters, then any additional V,L or B codes in the remaining characters are ignored. If both peat and coarse material are described outside the first one or two characters, then peat is always listed last.

For example:

S becomes S

SZ becomes SZ

SZC becomes SZ (C is outside the first 2 characters and is considered to be a minor, and relatively insignificant (i.e. not peat or coarse) component)

SZCV becomes SZV (although V is outside the first 2 characters, it is considered significant and is therefore included)

SZCB becomes SZV (for economy, V is used to represent all coarse material (V, L or B)

SZPB becomes SZVP (Outside the first 2 characters, P is considered secondary in importance to the presence of coarse material so is listed last)

3.3 SYMBOLISING THE SIMPLIFIED CODES

Effectively symbolising the rationalised set of codes is achieved by representing the primary lithology (1st character) as a solid colour, with each accessory lithological component shown as an overprinted symbol. The routine for symbolisation is described below.

For example the hypothetical lithology code: **ABCDEF**

Basic approach:

A – primary component, defines solid colour

B – secondary component (if exists) defines first pattern

In addition, the following rules ensure that peat and till characteristics are maintained, independent of their position in the code:

C,D,E,F – if any **C**,**D**,**E** or **F** component is coarser than sand (ie gravel, cobble or boulder), and **A** or **B** are not as coarse or coarser than gravel then apply a "coarse component" pattern (gravel (V) by default, to reduce the overall number of images and improve clarity)

C,D,E,F – if any **C**,**D**,**E** or **F** component is peat, and **A** or **B** are not peat, then apply peat pattern.

Example:

S corresponding solid colour only (gives S)

SZ  sand solid colour plus silt pattern (gives **Z**)

SZC  as above. For clarity, the clay component is not represented

SZCB  the occurrence of boulders is considered significant (more so than the clay), so the image shows solid sand, silt pattern and a "coarse component" pattern (gravel by default) (gives **SZV**).

SZCBP  as above, boulders and peat are considered significant, so the image shows solid sand, silt pattern, “coarse component” pattern and peat pattern (gives **SZVP**).

The full range of solid colours used to represent primary lithological component is shown below:

C - clay (R:153,G:176,B:190)

Z - silt (R:206,G:212,B:174)

S - sand (R:255,G:249,B:158)

V - gravel (R:247,G:195,B:0)

L - cobble (R:206,G:107,B:64)

B - boulder (R:220,G:19,B:123)

P - peat (R:188,G:130,B:92)

The full range of ornaments used to represent accessory lithological components is shown below:

C - clay  (Transparent background)

Z - silt  (Transparent background)

S - sand  (Transparent background)

V - gravel  (Transparent background)

L - cobble  (Transparent background)

B - boulder  (Transparent background)

P - peat  (Transparent background)

4 Use of the coding for display schemes, borehole coding, 3D modelling and thematic map making

4.1 BOREHOLE CODING AND 3D MODELLING

To show how the scheme is used in borehole coding and 3D modelling, some examples from the Vale of York are presented below. The figures show the original borehole log recorded to BS5930 standard (Figure 6), the interpretation and coding of that borehole (Figure 7), the display of similar borehole logs in GSI3D (Figure 8) and the display of logs in cross-sections and borehole views in GSI3D (Figures 9 and 10). In addition to its use for borehole coding, the scheme can be applied to logging auger hole sections and for exposures allowing them to be integrated with other 3D geology.

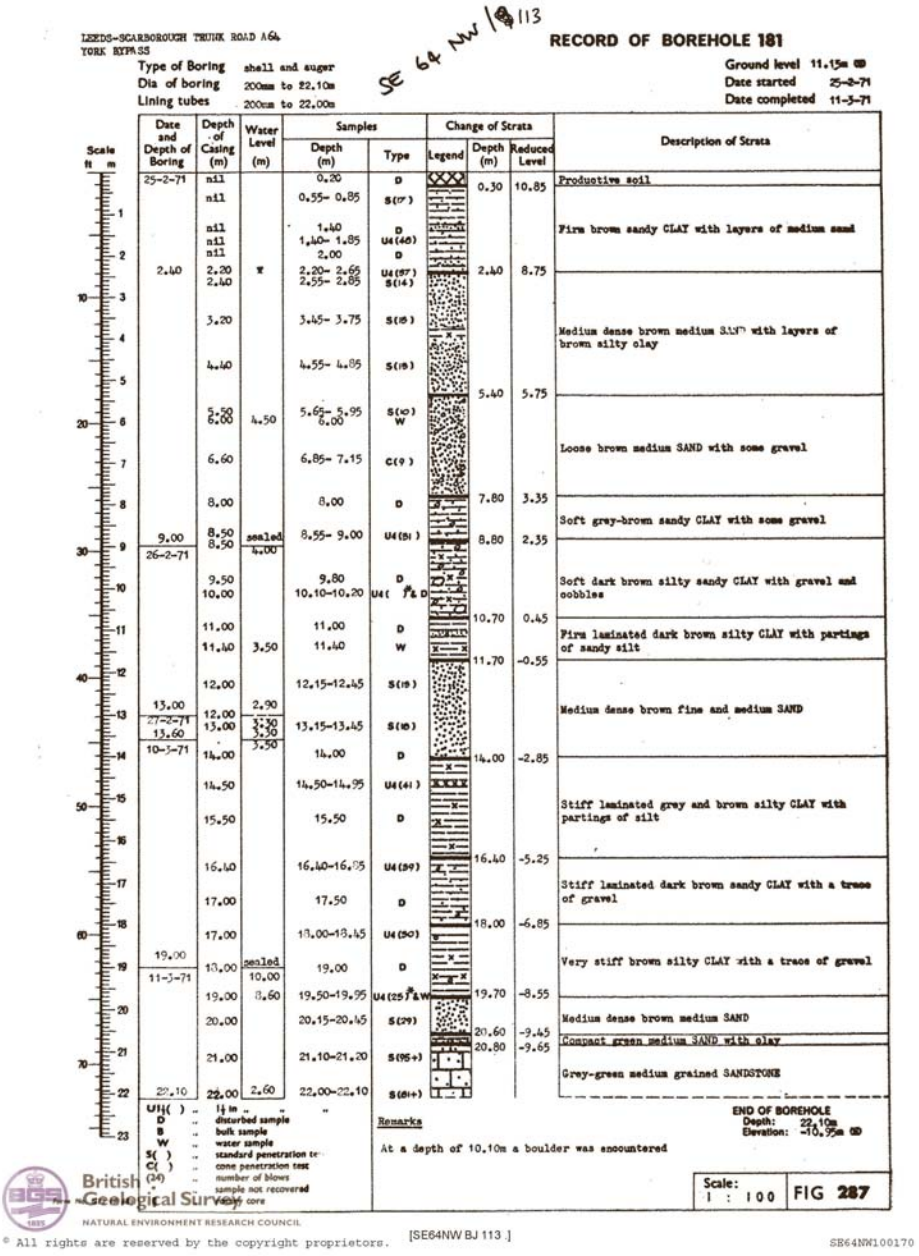


Figure 6 Typical modern site investigation borehole logged to BS5930 standard. In Figure 6 this has been coded using the unlithified deposits coding scheme.

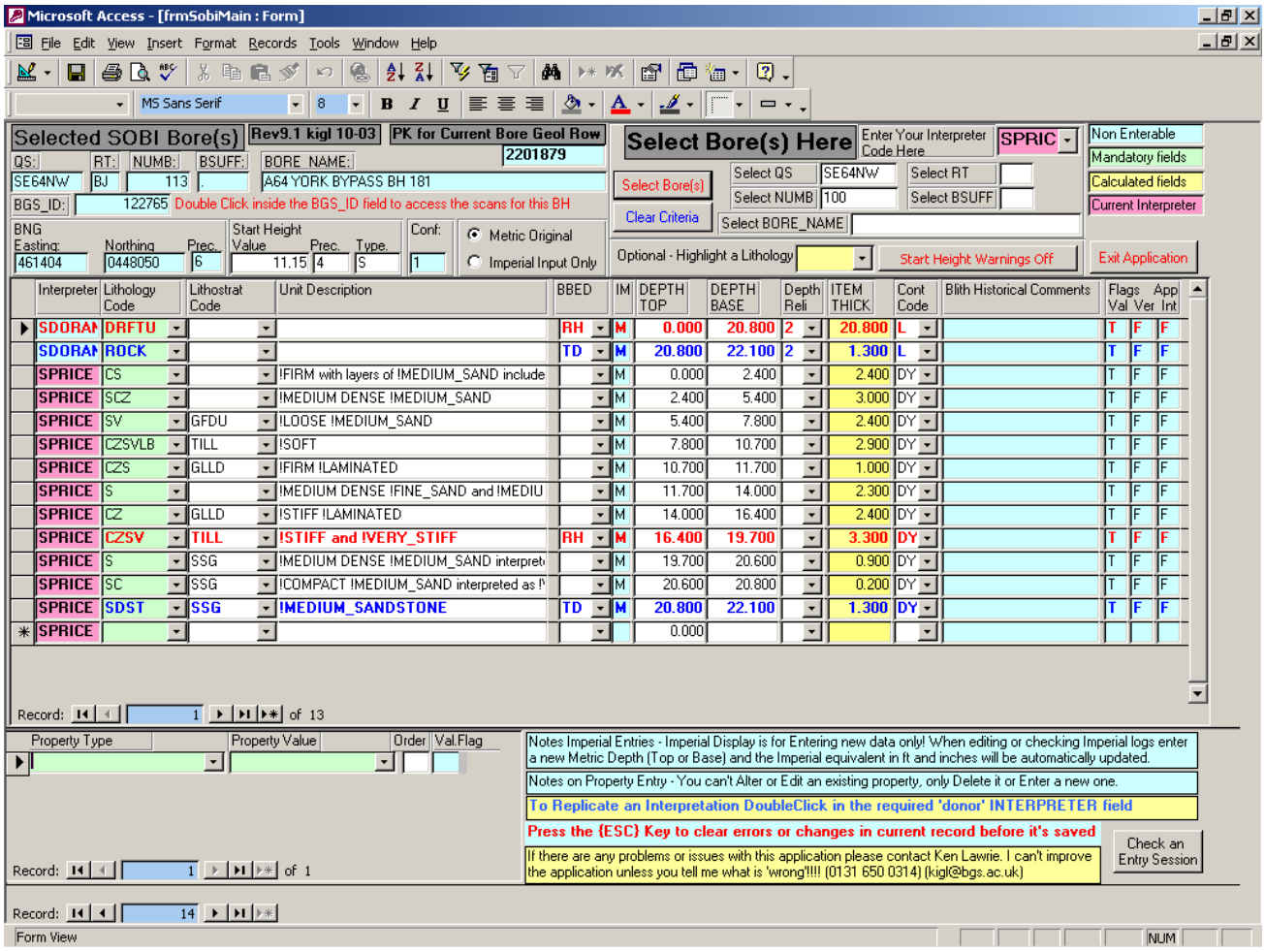
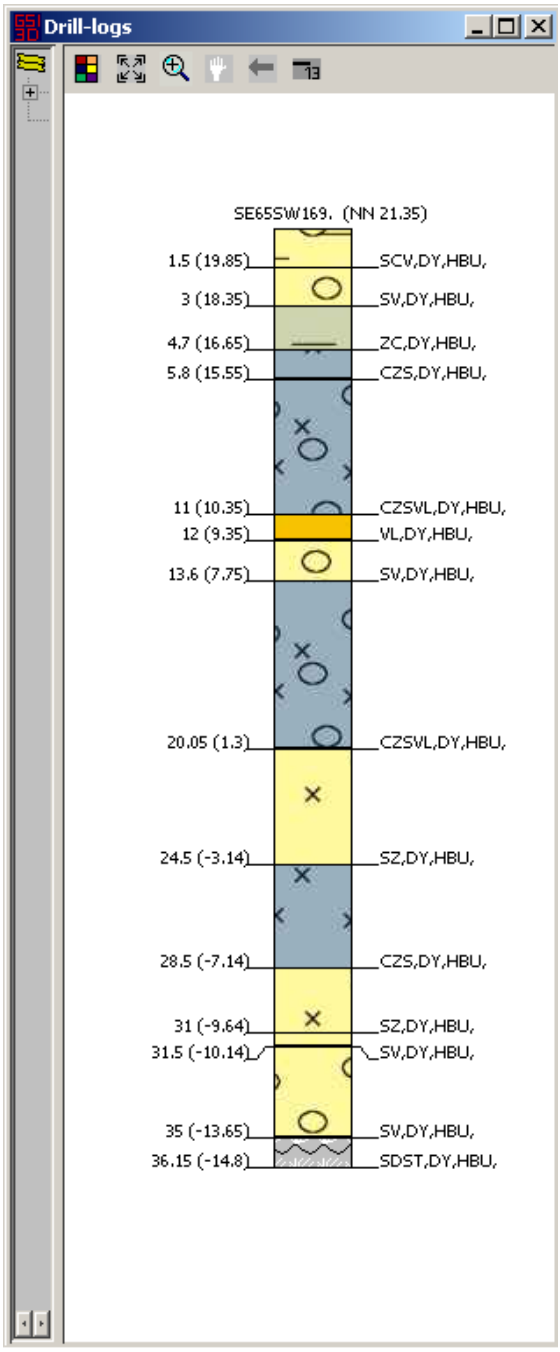


Figure 7 Access borehole input interface to the ORACLE BOGE (Borehole Geology) database showing the coding of unlithified deposits in the Lithology Code column; the original log is shown in Figure 5.



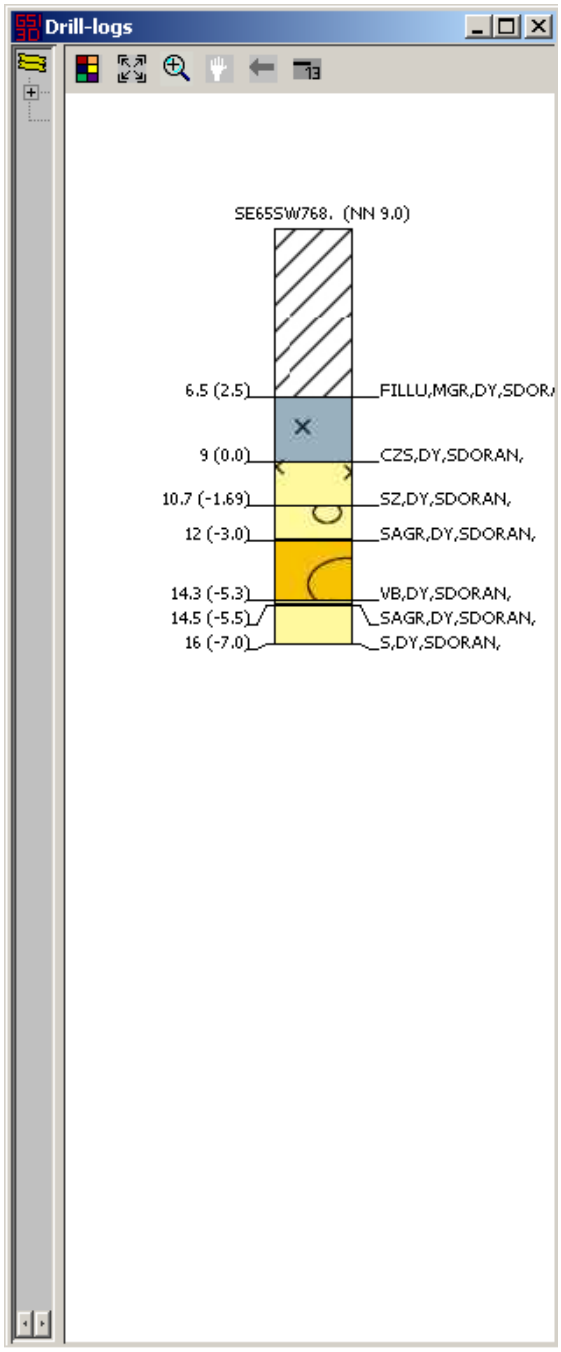


Figure 8 Borehole logs coded into BOGE and displayed in GSI3D with lithological ornament determined by the methodology described in section 3 of this report

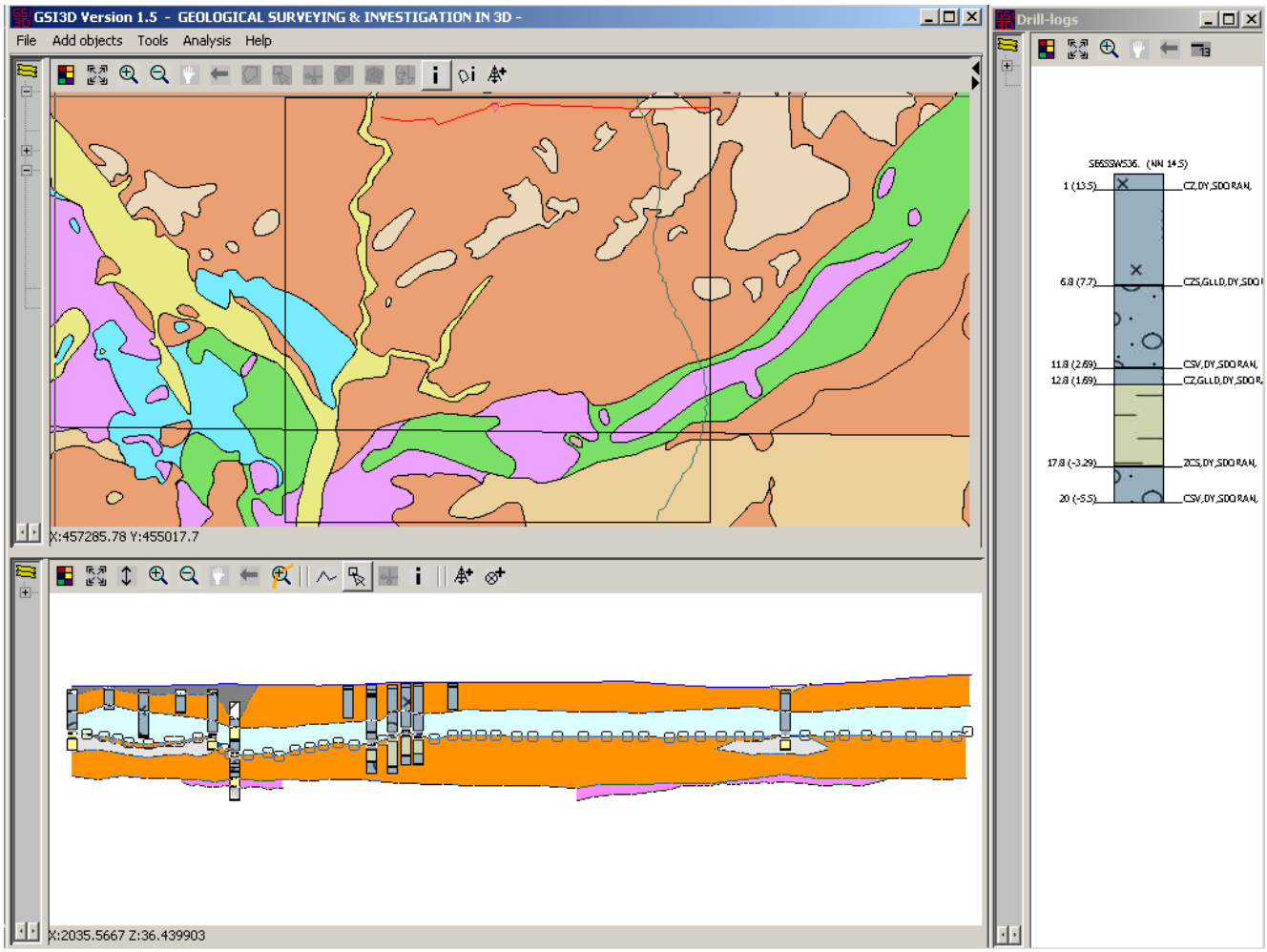


Figure 9 Cross section and borehole logs displayed in GSI3D. The ornament of all the borehole logs on both the section and the detailed log at the side are derived from the unlithified coding scheme information coded into BOGE for each borehole.

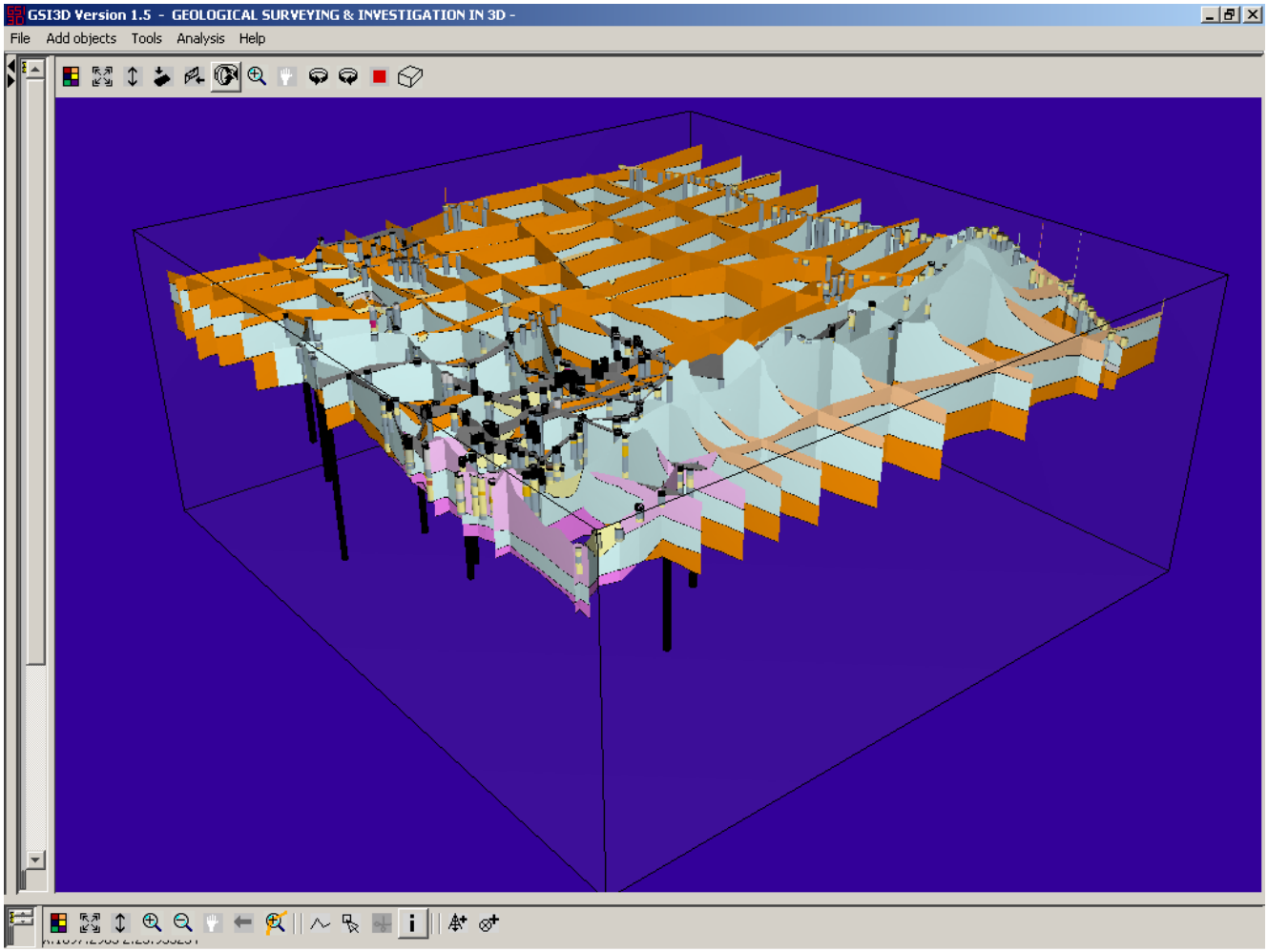


Figure 10 Borehole logs and cross-sections built by Simon Price into a 3D model for York using GSI3D. The ornaments on the borehole sticks are derived from the borehole coding using the unlithified deposits coding scheme.

Appendix 1 List of the basic codes

The table below is a list of the most common combinations of lithology that are presented using the information from the AGS listings and the combinations that occur in the triangular diagrams illustrated in the text. The full listing of all code combinations has 8660 entries and can be accessed via the Geoscience Standards and Nomenclature pages on the BGS intranet.

In the table below, some lithologies are shown in bold. These are the codes and descriptions for the combinations that are generated by the use of the simplification algorithm mentioned in the main report. This algorithm is used to simplify the data for the purposes of colouring and ornamenting in borehole viewers and as polygon attributes on geological maps. It is impractical to uniquely colour and ornament every combination of six letters in a code.

The listing of codes for use in the Unlithified Deposits Coding Scheme is based on:

CLAY: C
SILT: Z
SAND: S
GRAVEL: V
COBBLES: L
BOULDERS: B
PEAT: P

In the BGS scheme, the letters are used in decreasing order of amount present. To make the listing simple to use (searching, grouping etc), and the main lithology has been written first in capital letters. In engineering descriptions and BS5930, it is usual for the main lithology to appear after the qualifiers. Thus “SAND clayey gravelly” below would be described in the reverse (ascending) order as “clayey gravelly SAND” and both would have the code “SCV”.

The listing below has all the entries currently in the RCS scheme shown in black. Entries in bold appear in the concatenated list and ones to be added to that listing are shown in red. Codes in blue are the remainder of the codes required to complete the listing of AGS codes used by the Geodasy software. (22 codes to add to the system).

BS 5930 Description (IN REVERSE)	Former BGS code	New Code	AGS Geodasy No.
CLAY	**CLAY**	**C**	**201**
CLAY bouldery		**CB**	**206**
CLAY bouldery sandy		CBS	
CLAY bouldery sandy silty		CBSZ	213
CLAY bouldery silty		CBZ	210
CLAY bouldery cobbly		CBL	
CLAY bouldery peaty		**CBP**	
CLAY cobbly		**CL**	**205**
CLAY cobbly silty		CLZ	209
CLAY cobbly bouldery		CLB	
CLAY cobbly, peaty		**CLP**	
CLAY sandy	**SACL**	**CS**	**203**
CLAY sandy bouldery		CSB	
CLAY sandy bouldery cobbly		CSBL	
CLAY sandy cobbly		CSL	
CLAY sandy cobbly bouldery		CSLB	
CLAY sandy gravelly		CSV	

CLAY sandy gravelly bouldery		CSVB	
CLAY sandy gravelly bouldery cobbly		CSVBL	
CLAY sandy gravelly cobbly		CSVL	
CLAY sandy gravelly cobbly bouldery		CSVLB	
CLAY sandy gravelly silty		CSVZ	
CLAY sandy silty		CSZ	207
CLAY sandy silty gravelly		CSZV	
CLAY gravelly	**CLYGV**	**CV**	**204**
CLAY gravelly bouldery		CVB	
CLAY gravelly bouldery cobbly		CVBL	
CLAY gravelly bouldery sandy		CVBS	
CLAY gravelly bouldery sandy silty		CVBSZ	
CLAY gravelly bouldery silty		CVBZ	
CLAY gravelly bouldery silty sandy		CVBZS	
CLAY gravelly cobbly bouldery		CVLB	
CLAY gravelly sandy		**CVS**	**220**
CLAY gravelly sandy bouldery		CVSB	
CLAY gravelly sandy silty		CVSZ	
CLAY gravelly silty		CVZ	208
CLAY gravelly silty sandy		CVZS	
CLAY silty	**SICL**	**CZ**	**202**
CLAY silty bouldery		CZB	
CLAY silty cobbly		CZL	
CLAY silty sandy	SSCL	CZS	
CLAY silty sandy bouldery		CZSB	
CLAY silty sandy bouldery cobbly		CZSBL	
CLAY silty sandy cobbly		CZSL	212
CLAY silty sandy cobbly bouldery		CZSLB	
CLAY silty sandy gravelly		CZSV	211
CLAY silty sandy gravelly bouldery		CZSVB	215
CLAY silty sandy gravelly bouldery cobbly		CZSVBL	
CLAY silty sandy gravelly cobbly		CZSVL	214
CLAY silty sandy gravelly cobbly bouldery		CZSVLB	216
CLAY silty gravelly		**CZV**	
CLAY silty gravelly bouldery		CZVB	
CLAY silty gravelly bouldery cobbly		CZVBL	
CLAY silty gravelly cobbly bouldery		CZVLB	
CLAY silty gravelly sandy		CZVS	
CLAY peaty		**CP**	

CLAY peaty sandy		CPS	
CLAY peaty sandy gravelly		CPSV	
CLAY peaty sandy silty		CPSZ	
CLAY peaty sandy silty gravelly		CPSZV	
CLAY peaty silty		CPZ	
CLAY peaty silty sandy		CPZS	
CLAY peaty silty sandy gravelly		CPZSV	
CLAY sandy peaty		**CSP**	
CLAY sandy peaty silty		CSPZ	
CLAY sandy peaty silty gravelly		CSPZV	
CLAY sandy gravelly peaty		**CSVP**	
CLAY sandy gravelly peaty silty		CSVPZ	
CLAY sandy gravelly silty peaty		CSVZP	
CLAY sandy silty peaty		CSZP	
CLAY sandy silty gravelly peaty		CSZVP	
CLAY gravelly silty peaty		CVZP	
CLAY gravelly peaty		**CVP**	
CLAY gravelly peaty silty		CVPZ	
CLAY gravelly peaty sandy		CVPS	
CLAY gravelly peaty sandy silty		CVPSZ	
CLAY silty peaty		**CZP**	**219**
CLAY silty peaty sandy		CZPS	
CLAY silty peaty sandy gravelly		CZPSV	
CLAY silty peaty gravelly		CZPV	
CLAY silty sandy peaty		CZSP	217
CLAY silty sandy gravelly peaty		CZSVP	218
CLAY silty gravelly peaty		**CZVP**	
SILT	**SILT**	**Z**	**301**
SILT bouldery		**ZB**	**331**
SILT bouldery cobbly		ZBL	
SILT bouldery peaty		**ZBP**	
SILT clayey	**SLTCLY**	**ZC**	**302**
SILT clayey bouldery		ZCB	309
SILT clayey cobbly		ZCL	329
SILT clayey sandy		ZCS	306
SILT clayey sandy gravelly		ZCSV	312
SILT clayey gravelly		**ZCV**	

SILT clayey gravelly bouldery		ZCVB	
SILT clayey gravelly peaty		**ZCVP**	
SILT clayey gravelly sandy		ZCVS	
SILT cobbly		**ZL**	**326**
SILT cobbly bouldery		ZLB	327
SILT cobbly peaty		**ZLP**	
SILT sandy	**SLTSDY**	**ZS**	**303**
SILT sandy bouldery		ZSB	317
SILT clayey bouldery cobbly		ZSBL	
SILT sandy clayey		ZSC	
SILT sandy cobbly		ZSL	316
SILT sandy cobbly bouldery		ZSLB	
SILT sandy gravelly		**ZSV**	**310**
SILT sandy gravelly bouldery cobbly		ZSVBL	
SILT sandy gravelly clayey		ZSVC	308
SILT sandy gravelly cobbly		ZSVL	320
SILT sandy gravelly cobbly bouldery		ZSVLB	
SILT gravelly	**SLTGV**	**ZV**	**304**
SILT gravelly bouldery		ZVB	323
SILT sandy bouldery cobbly		ZVBL	
SILT gravelly clayey		ZVC	307
SILT gravelly clayey sandy		ZVCS	
SILT gravelly cobbly		ZVL	322
SILT sandy cobbly bouldery		ZVLB	
SILT gravelly sandy		ZVS	
SILT gravelly sandy clayey		ZVSC	
SILT clayey peaty		**ZCP**	**330**
SILT clayey sandy peaty		ZCSP	
SILT clayey sandy gravelly peaty		ZCSVP	313
SILT clayey sandy gravelly peaty cobbly		ZCSVPL	314
SILT peaty		**ZP**	**305**
SILT peaty clayey		ZPC	
SILT peaty clayey sandy		ZPCS	
SILT peaty cobbly		ZPL	328
SILT peaty sandy		ZPS	
SILT peaty sandy clayey		ZPSC	
SILT sandy clayey peaty		ZSCP	
SILT sandy clayey gravelly		ZSCV	
SILT sandy peaty		**ZSP**	**318**

SILT sandy peaty clayey		ZSPC	
SILT sandy gravelly peaty		**ZSVP**	**319**
SILT sandy gravelly peaty cobbly		ZSVPL	321
SILT gravelly peaty		**ZVP**	**324**
SILT gravelly peaty cobbly		ZVPL	325
SILT gravelly peaty sandy clayey		ZVPSC	
SAND	**SAND**	**S**	**401**
SAND bouldery		**SB**	**406**
SAND bouldery cobbly		SBL	
SAND clayey	**CLSA**	**SC**	**402**
SAND clayey bouldery		SCB	
SAND clayey bouldery cobbly		SCBL	
SAND clayey cobbly		SCL	
SAND clayey cobbly bouldery		SCLB	
SAND clayey gravelly		**SCV**	**410**
SAND clayey gravelly bouldery		SCVB	
SAND clayey gravelly bouldery silty		SCVBZ	
SAND clayey gravelly cobbly		SCVL	411
SAND clayey gravelly silty		SCVZ	
SAND clayey silty gravelly		SCZV	408
SAND clayey silty		SCZ	407
SAND clayey silty gravelly cobbly		SCZVL	409
SAND clayey silty gravelly cobbly bouldery		SCZVLB	
SAND cobbly		**SL**	**405**
SAND cobbly bouldery		SLB	418
SAND gravelly	**GVSNDU**	**SV**	**404**
SAND gravelly bouldery		SVB	417
SAND gravelly bouldery cobbly		SVBL	
SAND gravelly clayey		SVC	
SAND gravelly clayey bouldery cobbly		SVCBL	
SAND gravelly clayey cobbly bouldery		SVCLB	
SAND gravelly cobbly		SVL	416
SAND gravelly cobbly bouldery		SVLB	416
SAND gravelly silty		SVZ	
SAND gravelly silty clayey		SVZC	
SAND gravelly clayey silty		SVCZ	
SAND gravelly silty bouldery cobbly		SVZBL	
SAND gravelly silty cobbly bouldery		SVZLB	

SAND silty	**SISND**	**SZ**	**403**
SAND silty bouldery		SZB	
SAND silty bouldery cobbly		SZBL	
SAND silty clayey		SZC	
SAND silty clayey gravelly		SZCV	
SAND silty cobbly		SZL	
SAND silty cobbly bouldery		SZLB	
SAND silty gravelly		**SZV**	**412**
SAND silty gravelly cobbly		SZVC	413
SAND silty gravelly cobbly bouldery		SZVLB	414
SAND bouldery peaty		**SBP**	**436**
SAND clayey peaty		**SCP**	**432**
SAND clayey peaty silty		SCPZ	
SAND clayey silty peaty		SCZP	437
SAND clayey silty gravelly peaty		SCZVP	438
SAND cobbly peaty		**SLP**	**435**
SAND peaty		**SP**	**431**
SAND peaty clayey silty		SPCZ	
SAND peaty silty		SPZ	
SAND peaty silty clayey		SPZC	
SAND gravelly clayey peaty		SVCP	
SAND gravelly clayey silty		SVCZ	
SAND gravelly peaty		**SVP**	**434**
SAND gravelly peaty clayey		SVPC	
SAND gravelly peaty silty		SVPZ	
SAND gravelly silty peaty		SVZP	
SAND silty peaty		**SZP**	**433**
SAND silty gravelly peaty		**SZVP**	
GRAVEL	**GRAV**	**V**	**501**
GRAVEL bouldery		**VB**	**507**
GRAVEL bouldery cobbly		VBL	
GRAVEL bouldery peaty		**VBP**	
GRAVEL clayey	**CLGV**	**VC**	**502**
GRAVEL clayey bouldery		VCB	511
GRAVEL clayey bouldery cobbly		VCBL	
GRAVEL clayey cobbly		VCL	510
GRAVEL clayey cobbly bouldery		VCLB	
GRAVEL clayey sandy		VCS	509

GRAVEL clayey sandy silty		VCSZ	
GRAVEL clayey silty		VCZ	508
GRAVEL clayey silty bouldery		VCZB	515
GRAVEL clayey silty cobbly		VCZL	514
GRAVEL clayey silty sandy		VCZS	513
GRAVEL clayey silty sandy bouldery		VCZSB	518
GRAVEL cobbly		**VL**	**506**
GRAVEL cobbly bouldery		VLB	
GRAVEL cobbly peaty		**VLP**	
GRAVEL sandy		**VS**	**504**
GRAVEL sandy bouldery		VSB	526
GRAVEL sandy bouldery cobbly		VSBL	
GRAVEL sandy clayey		VSC	
GRAVEL sandy clayey silty		VSCZ	
GRAVEL sandy cobbly		VSL	525
GRAVEL sandy cobbly bouldery		VSLB	
GRAVEL sandy silty		VSZ	
GRAVEL sandy silty clayey		VSZC	
GRAVEL sandy peaty silty clayey		VSPZC	
GRAVEL silty	**GVSLTY**	**VZ**	**503**
GRAVEL silty bouldery		VZB	522
GRAVEL silty bouldery cobbly		VZBL	
GRAVEL silty clayey		VZC	
GRAVEL silty clayey sandy		VZCS	
GRAVEL silty clayey peaty		VZCP	
GRAVEL silty cobbly		VZL	521
GRAVEL silty cobbly bouldery		VZLB	
GRAVEL silty sandy		VZS	520
GRAVEL silty sandy cobbly		VZSL	528
GRAVEL clayey peaty		**VCP**	**512**
GRAVEL clayey sandy peaty		VCSP	517
GRAVEL clayey silty peaty		VCZP	516
GRAVEL clayey silty sandy peaty		VCZSP	519
GRAVEL peaty		**VP**	**506**
GRAVEL peaty sandy		VPS	
GRAVEL peaty sandy clayey		VPSC	
GRAVEL peaty clayey		VPC	
GRAVEL peaty clayey sandy silty		VPCSZ	
GRAVEL peaty clayey silty sandy		VPCZS	

GRAVEL sandy peaty		**VSP**	**527**
GRAVEL silty peaty		**VZP**	**523**
GRAVEL silty peaty clayey		VZPC	
GRAVEL silty peaty sandy		VZPS	524
COBBLES		**L**	
COBBLES bouldery		**LB**	**725**
COBBLES bouldery clayey		LBC	
COBBLES bouldery clayey sandy		LBCS	
COBBLES bouldery clayey sandy gravelly		LBCSV	
COBBLES bouldery clayey silty sandy		LBCZS	
COBBLES bouldery clayey silty sandy gravelly		LBCZSV	
COBBLES bouldery clayey silty gravelly		LBCZV	
COBBLES bouldery peaty		**LBP**	
COBBLES bouldery sandy		LBS	
COBBLES bouldery sandy clayey		LBSC	
COBBLES bouldery sandy gravelly		LBSV	
COBBLES bouldery sandy gravelly clayey		LBSVC	
COBBLES bouldery sandy silty		LBSZ	
COBBLES bouldery gravelly		LBV	
COBBLES bouldery gravelly clayey		LBVC	
COBBLES bouldery gravelly sandy		LBVS	
COBBLES bouldery gravelly silty		LBVZ	
COBBLES bouldery silty		LBZ	
COBBLES bouldery silty sandy		LBZS	
COBBLES bouldery silty sandy gravelly		LBZSV	
COBBLES bouldery silty gravelly		LBZV	
COBBLES bouldery sandy gravelly silty		LBSVZ	
COBBLES clayey		**LC**	**702**
COBBLES clayey sandy		LCS	708
COBBLES clayey sandy gravelly		LCSV	
COBBLES clayey gravelly		LCV	709
COBBLES clayey peaty		**LCP**	
COBBLES clayey silty sandy gravelly		LCZSV	712
COBBLES clayey silty gravelly		LCZV	711
COBBLES clayey silty gravelly sandy		LCZVS	
COBBLES sandy		**LS**	**704**
COBBLES sandy gravelly		LSV	719
COBBLES sandy gravelly clayey		LSVC	

COBBLES sandy gravelly silty		LSVZ	
COBBLES clayey silty		LSZ	707
COBBLES gravelly		**LV**	**705**
COBBLES gravelly clayey		LVC	
COBBLES gravelly sandy		LVS	
COBBLES gravelly silty		LVZ	
COBBLES silty		**LZ**	**703**
COBBLES silty sandy		LZS	713
COBBLES silty gravelly		LZV	714
COBBLES silty sandy gravelly		LZSV	
COBBLES silty gravelly sandy		LZVS	716
COBBLES peaty		**LP**	**706**
COBBLES sandy peaty		**LSP**	**720**
COBBLES gravelly peaty		**LVP**	**721**
COBBLES silty peaty		**LZP**	**715**
COBBLES silty sandy peaty		LZSP	717
COBBLES silty sandy gravelly peaty		LZSVP	718
BOULDERS		**B**	**730**
BOULDERS clayey		**BC**	
BOULDERS clayey peaty		**BCP**	
BOULDERS clayey sandy gravelly		BCSV	
BOULDERS clayey gravelly		BCV	
BOULDERS clayey silty sandy gravelly		BCZSV	
BOULDERS cobbly		**BL**	
BOULDERS cobbly clayey		BLC	
BOULDERS cobbly clayey sandy		BLCS	
BOULDERS cobbly clayey sandy gravelly		BLCSV	
BOULDERS cobbly clayey gravelly		BLCV	
BOULDERS cobbly clayey silty		BLCZ	
BOULDERS cobbly clayey silty sandy		BLCZS	
BOULDERS cobbly clayey silty sandy gravelly		BLCZSV	
BOULDERS cobbly clayey silty gravelly		BLCZV	
BOULDERS cobbly peaty		**BLP**	
BOULDERS cobbly sandy		BLS	
BOULDERS cobbly sandy clayey		BLSC	
BOULDERS cobbly sandy gravelly		BLSV	
BOULDERS cobbly sandy gravelly clayey		BLSVC	
BOULDERS cobbly sandy gravelly silty		BLSVZ	

BOULDERS cobbly sandy silty		BLSZ	
BOULDERS cobbly gravelly		BLV	
BOULDERS cobbly gravelly clayey		BLVC	
BOULDERS cobbly gravelly sandy		BLVS	
BOULDERS cobbly gravelly silty		BLVZ	
BOULDERS cobbly silty		BLZ	
BOULDERS cobbly silty sandy gravelly		BLZSV	
BOULDERS cobbly silty gravelly		BLZV	
BOULDERS peaty		**BP**	
BOULDERS sandy		**BS**	
BOULDERS sandy peaty		**BSP**	
BOULDERS sandy gravelly		BSV	
BOULDERS sandy gravelly clayey		BSVC	
BOULDERS sandy gravelly silty		BSVZ	
BOULDERS gravelly		**BV**	
BOULDERS gravelly clayey		BVC	
BOULDERS gravelly cobbly		BVL	731
BOULDERS gravelly peaty		**BVP**	
BOULDERS gravelly sandy		BVS	
BOULDERS gravelly silty		BVZ	
BOULDERS silty		**BZ**	
BOULDERS silty peaty		**BZP**	
BOULDERS sandy peaty		**BSP**	
BOULDERS silty sandy gravelly		BZSV	
BOULDERS silty gravelly		BZV	
PEAT	**PEAT**	**P**	**601**
PEAT clayey		**PC**	**602**
PEAT clayey sandy		PCS	608
PEAT clayey sandy silty		PCSZ	
PEAT clayey gravelly		**PCV**	**609**
PEAT clayey gravelly sandy silty		PCVSZ	
PEAT clayey gravelly silty sandy		PCVZS	
PEAT clayey silty		PCZ	607
PEAT clayey silty sandy		PCZS	
PEAT bouldery		**PB**	
PEAT cobbly		**PL**	**606**
PEAT sandy		**PS**	**604**
PEAT sandy clayey		PSC	

PEAT sandy gravelly		**PSV**	**614**
PEAT sandy silty		PSZ	
PEAT sandy clayey silty		PSCZ	
PEAT sandy silty clayey		PSZC	
PEAT gravelly		**PV**	**605**
PEAT gravelly clayey		PVC	
PEAT gravelly sandy		PVS	
PEAT gravelly sandy clayey silty		PVSCZ	
PEAT gravelly silty clayey		PVZC	
PEAT silty		**PZ**	**603**
PEAT silty clayey		PZC	
PEAT silty clayey sandy		PZCS	
PEAT silty sandy		PZS	
PEAT silty sandy clayey		PZSC	
PEAT silty sandy gravelly		PZSV	613
PEAT silty gravelly		PZV	

Appendix 2 Microsoft Excel function for batch code simplification / determination of appropriate symbology (for GSI3D)

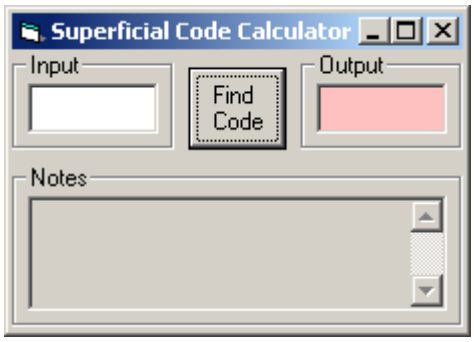
```
'This function returns the name of the most appropriate
'texture image file, based on criteria described in the
'corresponding note'
Function GET_FILENAME(cell_input As String) As String

   'Get input code

   'First check not null

   If cell_input = "" Then
      'Input code invalid (input code null)
      MsgBox ("Input code invalid (input code null)")
   End If

   Dim strCode As String
   strCode = cell_input

   'Convert input code to upper-case
   strCode = UCase(strCode)

   'Get component parts (upto 6 characters)
   Dim strA As String
   Dim strB As String
   Dim strC As String
   Dim strD As String
   Dim strE As String
   Dim strF As String

   strA = Mid(strCode, 1, 1)
   strB = Mid(strCode, 2, 1)
   strC = Mid(strCode, 3, 1)
   strD = Mid(strCode, 4, 1)
   strE = Mid(strCode, 5, 1)
   strF = Mid(strCode, 6, 1)

   'Declare output name holder
   Dim strFilename As String

   'Check that input code is valid
```

```
    'Check for interstitial or preceeding spaces

    If strA = " " Then
       If strB <> " " Or strC <> " " Or strD <> " " Or strE <> " " Or strF <> " " Then
          MsgBox ("Input code invalid (interstitial spaces)")
       End If
    End If

    If strB = " " Then
        If strC <> " " Or strD <> " " Or strE <> " " Or strF <> " " Then
          MsgBox ("Input code invalid (interstitial spaces)")
       End If
    End If

    If strC = " " Then
        If strD <> " " Or strE <> " " Or strF <> " " Then
          MsgBox ("Input code invalid (interstitial spaces)")
       End If
    End If

    If strD = " " Then
        If strE <> " " Or strF <> " " Then
          MsgBox ("Input code invalid (interstitial spaces)")
       End If
    End If

    If strE = " " Then
        If strF <> " " Then
          MsgBox ("Input code invalid (interstitial spaces)")
       End If
    End If

    'Check for invlaid characters

    If strA <> "C" And strA <> "Z" And strA <> "S" And strA <> "V" And strA <> "L" And strA <> "B" And strA <> "P" And strA <>
" " And strA <> "" Then
          MsgBox ("Input code invalid (invalid character used): " & strA)
    End If

    If strB <> "C" And strB <> "Z" And strB <> "S" And strB <> "V" And strB <> "L" And strB <> "B" And strB <> "P" And strB <>
" " And strB <> "" Then
          MsgBox ("Input code invalid (invalid character used): " & strB)
    End If
```

```
    If strC <> "C" And strC <> "Z" And strC <> "S" And strC <> "V" And strC <> "L" And strC <> "B" And strC <> "P" And strV
<> " " And strC <> "" Then
        MsgBox ("Input code invalid (invalid character used): " & strC)
    End If

    If strD <> "C" And strD <> "Z" And strD <> "S" And strD <> "V" And strD <> "L" And strD <> "B" And strD <> "P" And strD
<> " " And strD <> "" Then
        MsgBox ("Input code invalid (invalid character used): " & strD)
    End If

    If strE <> "C" And strE <> "Z" And strE <> "S" And strE <> "V" And strE <> "L" And strE <> "B" And strE <> "P" And strE <>
" " And strE <> "" Then
        MsgBox ("Input code invalid (invalid character used): " & strE)
    End If

    If strF <> "C" And strF <> "Z" And strF <> "S" And strF <> "V" And strF <> "L" And strF <> "B" And strF <> "P" And strF <> "
" And strF <> "" Then
        MsgBox ("Input code invalid (invalid character used): " & strF)
    End If

    'Check for duplicate characters

    Dim strColCharacters As New Collection
    strColCharacters.Add ("C")
    strColCharacters.Add ("Z")
    strColCharacters.Add ("S")
    strColCharacters.Add ("V")
    strColCharacters.Add ("L")
    strColCharacters.Add ("B")
    strColCharacters.Add ("P")

    Dim intCharacterCount As Integer

    For Each element In strColCharacters

        intCharacterCount = 0

        MsgBox ("Element: " & element)

        If strA = element Then
            intCharacterCount = intCharacterCount + 1
        End If

        If strB = element Then
            intCharacterCount = intCharacterCount + 1
        End If
```

```
        If strC = element Then
            intCharacterCount = intCharacterCount + 1
        End If

        If strD = element Then
            intCharacterCount = intCharacterCount + 1
        End If

        If strE = element Then
            intCharacterCount = intCharacterCount + 1
        End If

        If strF = element Then
            intCharacterCount = intCharacterCount + 1
        End If

        If intCharacterCount > 1 Then
            MsgBox ("Duplicate character: " & element)
        End If

    Next element
        'Create strFilename

    strFilename = strFilename & strA
    strFilename = strFilename & strB

    If strA <> "V" And strB <> "V" And strA <> "L" And strB <> "L" And strB <> "B" And strB <> "B" Then
        If strC = "V" Or strD = "V" Or strE = "V" Or strF = "V" Or strC = "L" Or strD = "L" Or strE = "L" Or strF = "L" Or strC = "B"
Or strD = "B" Or strE = "B" Or strF = "B" Then
            strFilename = strFilename & "V"
        End If
    End If
         'Check for "P" in C->F
    If strA <> "P" And strB <> "P" Then
        If strC = "P" Or strD = "P" Or strE = "P" Or strF = "P" Then
            strFilename = strFilename & "P"
        End If
    End If
       'strFilename = strFilename & ".jpg"

    GET_FILENAME = strFilename
End  Function
```

Appendix 3 Standalone application for individual code simplification




```
'This function returns the name of the most appropriate
'texture image file, based on criteria described in the
'corresponding report
'
Function GET_FILENAME(cell_input As String, txtTelem As TextBox) As String

    Dim intErrorCount As Integer
    intErrorCount = 0

    'Get input code

    'First check not null

    If cell_input = "" Then
        'Input code invalid (input code null)
        txtTelem.Text = txtTelem.Text & "Input code invalid (input code null)" & Chr$(13) & Chr$(10)
        intErrorCount = intErrorCount + 1
    End If

    Dim strCode As String
    strCode = cell_input

    'Convert input code to upper-case
    strCode = UCase(strCode)

    'Get component parts (upto 6 characters)
    Dim strA As String
    Dim strB As String
```

```
Dim strC As String
Dim strD As String
Dim strE As String
Dim strF As String

strA = Mid(strCode, 1, 1)
strB = Mid(strCode, 2, 1)
strC = Mid(strCode, 3, 1)
strD = Mid(strCode, 4, 1)
strE = Mid(strCode, 5, 1)
strF = Mid(strCode, 6, 1)

'Declare output name holder
Dim strFilename As String

'Check that input code is valid

'Check for interstitial or preceeding spaces

If strA = " " Then
   If strB <> " " Or strC <> " " Or strD <> " " Or strE <> " " Or strF <> " " Then
      txtTelem.Text = txtTelem.Text & "Input code invalid (interstitial spaces)" & Chr$(13) & Chr$(10)
      intErrorCount = intErrorCount + 1
   End If
End If

If strB = " " Then
    If strC <> " " Or strD <> " " Or strE <> " " Or strF <> " " Then
      txtTelem.Text = txtTelem.Text & "Input code invalid (interstitial spaces)" & Chr$(13) & Chr$(10)
      intErrorCount = intErrorCount + 1
   End If
End If

If strC = " " Then
    If strD <> " " Or strE <> " " Or strF <> " " Then
      txtTelem.Text = txtTelem.Text & "Input code invalid (interstitial spaces)" & Chr$(13) & Chr$(10)
      intErrorCount = intErrorCount + 1
   End If
End If

If strD = " " Then
    If strE <> " " Or strF <> " " Then
```

```
        txtTelem.Text = txtTelem.Text & "Input code invalid (interstitial spaces)" & Chr$(13) & Chr$(10)
        intErrorCount = intErrorCount + 1
      End If
    End If

    If strE = " " Then
       If strF <> " " Then
        txtTelem.Text = txtTelem.Text & "Input code invalid (interstitial spaces)" & Chr$(13) & Chr$(10)
        intErrorCount = intErrorCount + 1
      End If
    End If
     'Check for invlaid characters

    If strA <> "C" And strA <> "Z" And strA <> "S" And strA <> "V" And strA <> "L" And strA <> "B" And strA <> "P"
And strA <> " " And strA <> "" Then
      txtTelem.Text = txtTelem.Text & "Input code invalid (invalid character used): " & strA & Chr$(13) & Chr$(10)
      intErrorCount = intErrorCount + 1
    End If

    If strB <> "C" And strB <> "Z" And strB <> "S" And strB <> "V" And strB <> "L" And strB <> "B" And strB <> "P"
And strB <> " " And strB <> "" Then
      txtTelem.Text = txtTelem.Text & "Input code invalid (invalid character used): " & strB & Chr$(13) & Chr$(10)
      intErrorCount = intErrorCount + 1
    End If

    If strC <> "C" And strC <> "Z" And strC <> "S" And strC <> "V" And strC <> "L" And strC <> "B" And strC <>
"P" And strV <> " " And strC <> "" Then
      txtTelem.Text = txtTelem.Text & "Input code invalid (invalid character used): " & strC & Chr$(13) & Chr$(10)
      intErrorCount = intErrorCount + 1
    End If

    If strD <> "C" And strD <> "Z" And strD <> "S" And strD <> "V" And strD <> "L" And strD <> "B" And strD <>
"P" And strD <> " " And strD <> "" Then
      txtTelem.Text = txtTelem.Text & "Input code invalid (invalid character used): " & strD & Chr$(13) & Chr$(10)
      intErrorCount = intErrorCount + 1
    End If

    If strE <> "C" And strE <> "Z" And strE <> "S" And strE <> "V" And strE <> "L" And strE <> "B" And strE <> "P"
And strE <> " " And strE <> "" Then
      txtTelem.Text = txtTelem.Text & "Input code invalid (invalid character used): " & strE & Chr$(13) & Chr$(10)
      intErrorCount = intErrorCount + 1
    End If
```

```
    If strF <> "C" And strF <> "Z" And strF <> "S" And strF <> "V" And strF <> "L" And strF <> "B" And strF <> "P" And strF <> " " And strF <> "" Then
        txtTelem.Text = txtTelem.Text & "Input code invalid (invalid character used): " & strF & Chr$(13) & Chr$(10)
        intErrorCount = intErrorCount + 1
    End If

    'Check for duplicate characters

    Dim strColCharacters As New Collection
    strColCharacters.Add ("C")
    strColCharacters.Add ("Z")
    strColCharacters.Add ("S")
    strColCharacters.Add ("V")
    strColCharacters.Add ("L")
    strColCharacters.Add ("B")
    strColCharacters.Add ("P")

    Dim intCharacterCount As Integer

    For Each element In strColCharacters

        intCharacterCount = 0

        'MsgBox ("Element: " & element)

        If strA = element Then
            intCharacterCount = intCharacterCount + 1
        End If

        If strB = element Then
            intCharacterCount = intCharacterCount + 1
        End If

        If strC = element Then
            intCharacterCount = intCharacterCount + 1
        End If

        If strD = element Then
            intCharacterCount = intCharacterCount + 1
        End If

        If strE = element Then
```

```
            intCharacterCount = intCharacterCount + 1
        End If

        If strF = element Then
            intCharacterCount = intCharacterCount + 1
        End If

        If intCharacterCount > 1 Then
            txtTelem.Text = txtTelem.Text & "Duplicate character: " & element & Chr$(13) & Chr$(10)
            intErrorCount = intErrorCount + 1
        End If

    Next element

    'Create strFilename

    strFilename = strFilename & strA
    strFilename = strFilename & strB

    If strA <> "V" And strB <> "V" And strA <> "L" And strB <> "L" And strB <> "B" And strB <> "B" Then
        If strC = "V" Or strD = "V" Or strE = "V" Or strF = "V" Or strC = "L" Or strD = "L" Or strE = "L" Or strF = "L" Or
strC = "B" Or strD = "B" Or strE = "B" Or strF = "B" Then
            strFilename = strFilename & "V"
        End If
    End If

     'Check for "P" in C->F
    If strA <> "P" And strB <> "P" Then
        If strC = "P" Or strD = "P" Or strE = "P" Or strF = "P" Then
            strFilename = strFilename & "P"
        End If
    End If

    'strFilename = strFilename & ".jpg"

    If intErrorCount > 0 Then
        GET_FILENAME = "bad code"
    Else
        GET_FILENAME = strFilename
    End If

End Function
```

References

Most of the references listed below are held in the Library of the British Geological Survey at Keyworth, Nottingham. Copies of the references may be purchased from the Library subject to the current copyright legislation.

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