BRUCS: a new system for classifying and naming mappable rock units

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Abstract: A new scheme is introduced for classifying and naming mappable rock bodies that lack primary stratification. In recognition of their distinctive geological characteristics, these ‘nonstratiform’ bodies are defined and classified according to their 3D form, spatial distribution and genetic relationships, in two hierarchical (parent–child) chains: one for intrusions and one for tectonometamorphic units. Geologically complex units, encompassing bodies of different genetic classes, are classified in a third chain reserved specifically for ‘mixed-class’ units. The new classification scheme is offered as an alternative to existing recommendations in the International Stratigraphic Guide and North American Stratigraphic Code, in which nonstratiform bodies are recognized and defined primarily by their lithological character. BRUCS (the BGS Rock Unit Classification System) combines the three new parent–child chains for nonstratiform units with the well-established chain for stratiform units (bed–member–formation–group–supergroup) to create a flexible, practical and effective solution for classifying and naming all mappable rock bodies. The taxonomic rigour of BRUCS means that the considerable capabilities of modern digital systems for managing and communicating mapping data can be exploited fully.

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How we classify and name mappable rock bodies is fundamentally important in geology, for two main reasons. First, the approach we choose guides and influences our decisions about how rock bodies should be recognized, how they are related and how they should be divided or grouped. Second, and equally important, the end-result communicates those decisions to others, allowing them to be applied, tested and correlated, thereby advancing geological understanding. A systematic and consistent approach to both classification and nomenclature, at a national and, ideally, a global scale, is desirable for several reasons, not least because it simplifies correlation and reduces ambiguity. Modern digital systems offer increasingly powerful means of storing, organizing, searching, linking, displaying and sharing geological data, but their effectiveness in this regard is limited by data propriety. Thus, the ideal taxonomic system for rock bodies will provide both the flexibility that geologists need to resolve complex natural associations and the rigour that allows modern digital systems to function optimally.

All mappable rock bodies can be classified to a first order according to whether they conform to the Law of Superposition (first formulated by Nicolaus Steno in 1669). Those that do comprise layered successions of sedimentary and/or extrusive igneous rocks, and can be described as ‘stratiform’. Those that do not consist predominantly of intrusive, highly deformed and/or highly metamorphosed rocks, and can be described as ‘nonstratiform’.

In recent decades, the British Geological Survey (BGS) has converted its analogue geological maps and records of the UK into digital datasets and products. This task required all of the mapped rock bodies of the UK to be classified and named in a consistent, logical (i.e. database-friendly) and geologically appropriate manner. During that process, it became apparent that the guidance relating to nonstratiform bodies in the two most widely used schemes for classifying and naming rock bodies, the International Stratigraphic Guide and the North American Stratigraphic Code, did not allow that goal to be realized satisfactorily, in the UK at least. In this paper, we review the relevant guidance in those schemes and then consider the key requirements of a modern, robust taxonomic scheme for nonstratiform bodies, based on the UK experience. We then describe a new scheme for classifying and naming nonstratiform bodies that takes into account all of those key requirements and that experience, and we explain how that new scheme for nonstratiform bodies has been combined with the well-established scheme for stratiform bodies to create BRUCS (the BGS Rock Unit Classification System), a unified system for classifying and naming all rock bodies at all normal mapping scales. BRUCS has been used successfully in the UK, where it has been shown to meet both the scientific needs of practitioners and the practical demands of the digital age; the scheme therefore may have worldwide application.

Existing recommendations for classifying and naming nonstratiform bodies

For several decades, most efforts to classify and name mappable rock bodies have drawn on the recommendations presented in two authoritative schemes (Fig. 1): the International Stratigraphic Guide (ISG; International Subcommission on Stratigraphic Classification, ISSC 1976, 1994; Murphy and Salvador 1999), and the North American Stratigraphic Code (NASC; North American Commission on Stratigraphic Nomenclature, NACSN 1983, 2005). Both the ISG and NASC take as their basis the principles of stratigraphy, the branch of geology concerned with the order and relative positions of rock units, and provide guidance on the different types of stratigraphic unit that are now widely recognized, including lithostratigraphic, biostratigraphic and chronostratigraphic units. Both schemes agree that the ‘basic units’ of mapping and general geological work are rock bodies defined primarily by their lithological properties.

A key element of the ISG is the simple, and now well-established, parent–child chain that forms the basis for classifying and naming stratiform rock bodies, namely bed–flow–member–formation–...
The term (may be divided into subgroups) and rank to the chain between formation and group (Fig. 1). The formation is considered the ‘primary unit of lithostratigraphy’ in the ISG. In classification, formations are identified first and the ranks below and above that rank allow formations to be subdivided or grouped, respectively. The method recommended for naming units is to combine a geological name with the appropriate unit term to indicate the rank; for example, the Someplace Formation. This scheme works well for stratiform rock bodies and has been applied widely to such bodies in many geological settings.

The ISG considers nonstratiform bodies to be lithostratigraphic units too, but does not provide a set of unit terms for nonstratiform bodies that is comparable with those used for stratiform bodies. The parent–child chain for ‘lithodemic’ (i.e. nonstratiform) units was introduced in the NASC and has not been adopted by the ISG. The NASC considers lithodeme, suite and supersuite to be comparable with formation, group and supergroup, respectively.

<table>
<thead>
<tr>
<th>Rank 6</th>
<th>Rank 5</th>
<th>Rank 4</th>
<th>Rank 3</th>
<th>Rank 2</th>
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<tr>
<td>bed</td>
<td>flow</td>
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<tr>
<td>member</td>
<td>formation</td>
<td>subgroup</td>
<td>group</td>
<td>supergroup</td>
<td></td>
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<tr>
<td>lithodeme</td>
<td></td>
<td>suite</td>
<td></td>
<td></td>
<td>supersuite</td>
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</table>

Fig. 1. Key features of the ISG and NASC schemes for classifying rock units distinguished primarily by lithological properties. The parent–child chain for ‘lithostratigraphic’ units is used to classify stratiform bodies in both the International Stratigraphic Guide (ISG) and North American Stratigraphic Code (NASC). The ISG considers nonstratiform bodies to be lithostratigraphic units too, but does not provide a set of unit terms for nonstratiform bodies that is comparable with those used for stratiform bodies. The parent–child chain for ‘lithodemic’ (i.e. nonstratiform) units was introduced in the NASC and has not been adopted by the ISG. The NASC considers lithodeme, suite and supersuite to be comparable with formation, group and supergroup, respectively.

Lithostratigraphic units

<table>
<thead>
<tr>
<th>Lithostratigraphic units</th>
<th>bed</th>
<th>flow</th>
<th>formation</th>
<th>subgroup</th>
<th>group</th>
<th>supergroup</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lithodemic units</td>
<td></td>
<td></td>
<td>lithodeme</td>
<td></td>
<td>suite</td>
<td>supersuite</td>
</tr>
</tbody>
</table>

group–supergroup. The ISG allows that ‘Exceptionally, a group may be divided into subgroups’, which effectively adds another unit term (subgroup) and rank to the chain between formation and group (Fig. 1). The formation is considered the ‘primary unit of lithostratigraphy’ in the ISG. In classification, formations are identified first and the ranks below and above that rank allow formations to be subdivided or grouped, respectively. The method recommended for naming units is to combine a geological name with the appropriate unit term to indicate the rank; for example, the Someplace Formation. This scheme works well for stratiform rock bodies and has been applied widely to such bodies in many geological settings.

The ISG considers nonstratiform bodies to be lithostratigraphic units, because they are ‘defined, classified, and mapped on the basis of their distinguishing lithologic properties and stratigraphic relationships’. However, the ISG also acknowledges that ‘most geologists may agree that the terms group, formation, and member imply stratification and position within a stratified sequence showing original layering’, and suggests that for nonstratiform bodies ‘it may be more appropriate to use simple field lithologic terms such as granite, gneiss, and schist’ in place of the standard unit terms. Additional guidance on how nonstratiform bodies should be classified and named is rather limited and vague, and neither a set of unit terms nor a classification hierarchy comparable with that applied to stratiform bodies is provided. The use of lithologic terms in place of unit terms yields names like Someplace Granite and Someplace Schist, but these names do not denote a rank and therefore do not allow a hierarchical classification. Using terms that ‘express form or structure, as, for example, dikes, sills, batholiths, plutons, diapirs, stocks, pipe and neck’ or the more general term ‘intrusion’ in unit names is strongly discouraged in the ISG, on the basis that such terms ‘do not indicate the lithology of the rock body, are not unit-terms in the lithostratigraphic hierarchy, and are not, therefore, lithostratigraphic terms’. The term ‘complex’ is allowed for ‘igneous and/or metamorphic rock bodies of diverse and irregularly mixed lithology, whether or not they are strongly deformed and/or metamorphosed’, and should be used to indicate that ‘the stratigraphic relations of the individual lithologies ... are poorly known or unidentifiable and that the body, therefore, cannot be subdivided on stratigraphic grounds’; again, the term carries no connotation of rank. Using the term ‘suite’ is considered ‘inadvisable’, on the basis that ‘the term has been commonly used for associations of apparently co-magmatic intrusive igneous rock bodies of similar or related lithologies and close association in time, space, and origin’. There is no guidance on how nonstratiform bodies should be grouped or divided.

The NASC adopted, with minor amendments, the ISG recommendations for classifying and naming stratiform bodies but introduced a new concept and term, the lithodemic unit, for nonstratiform bodies. This was done specifically to address perceived limitations in the way both the ISG and precursors to the NASC treated such bodies, and the ‘recognized need to develop modes of establishing formal non-stratiform ... rock units’. Nonstratiform (lithodemic) and stratiform (lithostratigraphic) bodies are thus considered distinct, and so are treated in different ways in the NASC (NACSN 1983, 2005). The NASC defines a lithodemic unit as ‘a defined body of predominantly intrusive, highly deformed, and (or) highly metamorphosed rock, distinguished and delimited on the basis of rock characteristics’. Lithodeme is the ‘fundamental unit’ in lithodemic classification, and thus performs a similar role to formation in the classification of stratiform units. Two or more associated lithodemes of the same class (e.g. composed entirely of intrusive rock) can be grouped in a suite, and two or more suites ‘having a degree of natural relationship to one another’ can be grouped within a supersuite. These three types of lithodemic unit effectively define a hierarchy of three ranks (Fig. 1). Lithodeme, suite and supersuite are considered comparable with formation, group and supergroup, respectively, ‘for cartographic and hierarchical purposes’ (Fig. 1). The absence of formally recognized lithodemic units equivalent to member and bed means that any subdivision of a lithodeme is informal. The term ‘complex’ has a more specific meaning in the NASC than it does in the ISG. Following a recent slight revision to the definition (Easton et al. 2016), ‘complex’ is a lithodemic unit comprising ‘An assemblage or mixture of rocks, typically of two or more genetic classes, i.e., igneous, sedimentary, or metamorphic, with or without highly complicated structure’; the term may be assigned ‘where the mapping of each separate lithic component is impractical at ordinary mapping scales’. Complex is unranked in the NASC but is considered ‘commonly comparable to suite or supersuite’; two or more associated complexes can be grouped within a supersuite. The approach used to name lithodemic units is to combine a geographical name with a ‘descriptive or appropriate rank term’. Although it is not stated explicitly in the NASC, the unit term lithodeme apparently is not intended to be used in unit names.
When naming lithodemes, a lithological term is preferred (e.g. *Someplace Granite, Someplace Schist*), but in recognizing that ‘many bodies of intrusive rock… are difficult to characterize with a single lithic term’ the important exception is made that a term to ‘denote form (e.g. dike, sill)’, or a term that is ‘neutral (e.g. intrusion, pluton)’ can be used instead, if necessary; thus, names like *Someplace Pluton and Someplace Intrusion* are permissible. However, definitions for such ‘form’ terms, and guidance on how a ‘fundamental unit’ (lithodeme) should be identified, and where appropriate divided, are not provided. Furthermore, because the lithological terms and form terms do not denote a rank, it is unclear how any hierarchical classification below the rank of suite should be constructed. For suites, an adjective ‘denoting the fundamental character’ is added, creating names like *Someplace Metamorphic Suite and Someplace Plutonic Suite*.

Shortly after the NASC was first published in 1983, the International Subcommission on Stratigraphic Classification (ISSC) completed a review of the ‘stratigraphic classification and nomenclature of igneous and metamorphic rock bodies’ (ISSC 1987), and drew two important conclusions. First, and having appraised the issues behind the ‘considerable disagreement’ over whether the study of nonstratiform rock bodies should be considered part of stratigraphy, the ISSC concluded that ‘intrusive igneous bodies and metamorphic rocks of undetermined origin have unequivocal stratigraphic significance and should be included … within the scope of stratigraphy and stratigraphic investigation. They are, therefore, subject to the rules of stratigraphic classification and nomenclature.’ Second, and having considered the introduction of lithodemic units by the NASC, the ISSC concluded that ‘it does not seem advisable … to establish a new category of stratigraphic units and a new hierarchy of terms only on the basis of compliance or non-compliance with the Law of Superposition. It is preferable to consider all kinds of rock bodies that are defined and recognized on the basis of their diagnostic lithology as lithostratigraphic units.’

The different ways in which the ISG and NASC view and treat nonstratiform bodies has remained essentially unchanged in later editions and reprints of both schemes (ISSC 1994 (reprinted 2013); Murphy and Salvador 1999; NACSN 2005). The ISSC has made clear it is content to allow the ‘tests of time and usage … to … determine the ultimate practicality and validity of the practices and procedures advocated [by both schemes]’ (ISSC 1987). To date, however, no consensus has emerged, effectively leaving geologists without a scheme for classifying and naming nonstratiform rock bodies that is comparable, in terms of its utility and global reach, with the existing scheme for stratiform bodies. Several authors have highlighted perceived flaws with the ISG and NASC schemes. For example, Laajoki (1988) argued against the approach advocated in the ISG and in favour of the ‘dual classification to lithology-based stratigraphy’ advocated in the NASC, and commented that ‘To unite the lithology-based stratigraphy of rock strata … with that of massive igneous bodies [as in the ISG] … entangles stratigraphy as a science and lowers its value as a framework knowledge for petrological and other studies of rock bodies.’ Rawson et al. (2002) noted that the ISG ‘provides little help to geologists mapping in complicated basement and plutonic terrains’, and highlighted several perceived shortcomings with the NASC, including the inadequacy of a three-rank hierarchy, problems in applying the recommendations to zoned plutons, and issues surrounding the use of the term ‘complex’. A category of mappable unit that is not included in the ISG and NASC recommendations, the tectonostratigraphic(al) unit, is recognized and used alongside ‘lithostratigraphic’ and ‘lithodemic’ units in Norway, Finland and Sweden (Nystuen 1989; Strand et al. 2010; Kumpulainen 2017), where tectonically displaced allochthonous sheets are developed on a regional scale. A tectonostratigraphic unit in this context is defined as ‘a generally flat-lying, scale-independent, tectonic unit that is bounded by zones of high strain’ (Kumpulainen 2017).

**Requirements of a new scheme for classifying and naming nonstratiform bodies**

In the 1990s, the British Geological Survey (BGS) began converting analogue maps and records into digital datasets describing the geology of the UK; these include a publicly accessible database of all the named rock units of the UK (The BGS Lexicon of Named Rock Units (BGS 2020a)), and a range of digital geological maps (e.g. *DiGMapGB-50* (BGS 2020b) and the latest 1:625 000 scale map of the UK (BGS 2008a,b)). With this change came a need to manage relevant data within multiple linked relational databases, and thus the requirement to apply rigorous and consistent standards to the method of how mapped rock bodies of the UK are classified, named and organized at a nationwide scale. In the course of reassessing UK geology for that purpose, it became clear that neither the ISG nor NASC provided an adequate solution for classifying and naming the nonstratiform rock bodies of the UK (Gillespie et al. 2008; Leslie et al. 2012), and that a new scheme was needed. The key requirements of that new scheme, as deduced from the reassessment of UK bodies and subsequent attempts to create hierarchical classifications of nonstratiform units for use in BGS databases and digital products, are summarized below.

**Nonstratiform bodies should not be considered part of stratigraphy**

Nonstratiform rock bodies do not conform to the Law of Superposition, and thus are of fundamentally different character to stratiform bodies. As such, they should not ‘fall within the general scope of stratigraphy and stratigraphic classification’ as advocated in the ISG, although undoubtedly they can (and do) contribute to stratigraphic knowledge through absolute and relative geochronology. Instead, separate classification schemes for stratiform and nonstratiform bodies should be provided that acknowledge their differences and cater to their separate needs. Ideally, however, those separate schemes should be complementary so that they can be used together, with minimal difficulty, in areas (and in datasets) containing both stratiform and nonstratiform bodies.

**Genetically distinct classes of nonstratiform unit should be recognized**

The great majority of rock bodies are created by just a small number of geological processes: by *accumulation* of various materials at Earth’s surface (through deposition, effusion, evaporation, etc.); by *emplacement* of magma in the subsurface; and by *deformation* and/or *metamorphism* of pre-existing rocks. Classified units that group more than one mapped body can be categorized according to whether those bodies are of one genetic class (e.g. all formed by emplacement), or more than one class (e.g. some formed by emplacement and some by accumulation). Thus, classified units are either ‘single-class’ or ‘mixed-class’. Two categories of single-class nonstratiform unit can be recognized and should be distinguished: those formed by emplacement of magma (i.e. intrusions), and those formed by deformation and/or metamorphism. Only one category of single-class stratiform unit, those formed by accumulation, need be recognized; such units typically form stratigraphic successions.

**Nonstratiform bodies should be classified hierarchically**

A hierarchical system of classification, where components are organized by rank, and related rock bodies can be divided or grouped along a parent–child chain, has been shown to work well
for stratiform bodies (i.e. the well-established bed–member–
formation–group–subgroup chain advocated in the ISG and
NASC). The advantages of a hierarchical system apply equally well
to intrusions (for example, related dykes can be grouped within a
dyke-swarm, a dyke-swarm can be grouped with other related
intrusions into a parent unit of higher rank, and so on); the concept
of classifying intrusions hierarchically has existed for some time
(e.g. NASCN 1983; White et al. 2001). The geological validity of
classifying bodies formed by deformation and/or metamorphism in
a hierarchical manner is perhaps less obvious, but a comparable
system of classification for such bodies would allow them to be
grouped with those of other single-class categories (e.g. intrusions)
to form mixed-class units, and so is desirable for that reason alone.

A hierarchical classification of nonstratiform bodies therefore
makes sense, and it follows that a hierarchy of unit types should
form the basis of a classification scheme. However, it is important to
stress that the nature of a hierarchical relationship, and therefore the
evidence-base needed to support it, is very different in nonstratiform
and stratiform bodies. A hierarchical relationship in a stratiform
succession generally manifests at outcrop as a spatially ‘nested’
arrangement of the component units, where, for example, a member
typically exists within the extent of its parent formation, and a
formation typically exists within the extent of its parent group. By
contrast, related nonstratiform units can be dispersed and/or
contiguous and/or nested at outcrop; this means they are often
distributed in a much less regular and predictable way than
stratiform units, so a hierarchical relationship is usually less easy to
establish and demonstrate on the basis of field relations alone. The
individual intrusions associated with a major tectonothermal
episode might, for example, be scattered across tens of thousands
of square kilometres, and confirming the existence and nature of a
genetic relationship between the component units in such a situation
will generally require detailed laboratory analysis (e.g. mineral and
whole-rock geochemistry, isotope geochemistry and geochron-
ology) as a complement to mapping data.

**Nonstratiform bodies should be delimited by their
geospatial boundary**

In the ISG and NASC, the boundaries of lithostratigraphic and
lithodemic units are ‘placed at positions of lithologic/lithic change’.
Whereas this may be a helpful starting point for some stratiform
successions, it makes less sense for nonstratiform bodies because
many have inherent, well-defined geological boundaries that can
manifest in various ways. For example, all intrusions (initially at
least) are delimited by a contact, and most bodies produced by
deformation are delimited by faults or shear zones. Thus, a range of
other features, including chilled margins and zones of deformation,
may be at least as important as lithological change in identifying
such boundaries. Furthermore, a significant proportion of nonstrati-
form bodies are markedly and irregularly heterolithic as a
consequence of, for example, a complex history of magmatism,
deformation or metamorphism; such bodies will contain numerous
examples of lithological change that are irrelevant in defining a
meaningful mapped boundary. Consequently, geologists mapping
nonstratiform bodies generally look first for discrete, inherent
geological boundaries, however they manifest; only part of the
defining character of such boundaries may be put down to
lithological change.

**Nonstratiform bodies should be defined primarily by their
3D form**

The 3D form of the smallest mappable nonstratiform bodies can
usually be determined or inferred by mapping, albeit with varying
degrees of confidence. The great majority of intrusions display a
restricted set of form types, for which a set of well-established terms
already exists (e.g. pipe, dyke, laccolith, pluton). Groups of related
intrusions often share the same form type because they have similar
magma character and/or were emplaced into the same tectonic
environment. Form can therefore play an important role in
identifying and defining related intrusions, and can convey useful
information about geological setting. Although perhaps less
significant, the form displayed by bodies of deformed and/or
metamorphosed rock nevertheless can be useful; for example,
bodies with rectilinear and lensoidal boundaries are likely to have
developed in different tectonic settings. For these reasons, form
should be a key criterion in classifying and naming individual
nonstratiform bodies, and should play a role in identifying groups of
related bodies.

**Nonstratiform units should be grouped primarily on the
basis of genetic relationship**

A scheme for classifying nonstratiform bodies should reflect
modern research goals and current geological understanding if it
is to be useful and widely adopted. In recent decades, the main
objective of research involving intrusions has been to understand
their genesis, in particular the nature of source rocks, controls on
melting and emplacement, processes involved in magma evolution,
and relationships to large-scale crustal events such as subduction
and orogeny. Thus, groups of related intrusions, such as might be
indicated in map legends and discussed in scientific journals, are
usually recognized on the basis of interpretations regarding their
genesis, in particular whether they are inferred to be comagmatic or
cogenetic. Similarly, research will aim to set mappable bodies of
deformed rocks, such as those within a large shear zone, in the
context of the causative deformation event(s). Thus, the primary
criterion for grouping nonstratiform bodies in a hierarchical
classification should be the current understanding of their genetic
relationships. Interpretations of a genetic relationship can be based
on whatever information is available at the time. For example, an
inferred genetic relationship between a number of dykes can be
based initially on observable field criteria, such as lithological
similarity and co-alignment; additional, more sophisticated data
(e.g. laboratory analyses) obtained at a later date may provide a more
robust basis for the interpretation or indicate that a new
interpretation is required. Successful classifications must be
reasonably robust (not incorporating too much fine detail, and not
subject to frequent change), so genetic interpretation should be used
judiciously, particularly in situations where there is not yet a mature
understanding of such relationships.

**A classification hierarchy for nonstratiform units should have six formal ranks**

Logically, the smallest mappable bodies should be classified in the
lowest rank of a hierarchy, with groups of related bodies
representing increasingly broad ‘families’ classified in successively
higher ranks. The highest formal rank of a hierarchy ideally would
unite all the units of a particular genetic class that formed in
association with a major tectonothermal episode, regardless of their
present geographical distribution. How many ranks might ultim-
ately be needed to accommodate the most complex situations
globally (e.g. all bodies related to a continent-scale tectonothermal
episode) is not clear. However, it has been shown that all the
nonstratiform bodies of the UK can be classified adequately in a
hierarchy spanning six ranks (Gillespie et al. 2012; Leslie et al.
2012). The well-established hierarchy for stratiform units also has
six ranks (when subgroup is included), and a unified classification
system for all (stratiform and nonstratiform) rock units arguably is
more logical and more likely to be successful if the different
hierarchies within it have the same number of ranks. A hierarchy of six formal ranks therefore seems a pragmatic solution for nonstratiform units, and does not preclude the possibility that one or more ranks above the top rank could be added informally if needed.

**Tripartite names should be permissible for nonstratiform units**

In the context of a taxonomic system for mappable rock bodies, the goal of nomenclature is to differentiate units and, within reason, communicate key information about them. Both the ISG and NASC advocate that names assigned to nonstratiform units should generally be bipartite, comprising a geographical name and a lithological or ‘descriptive’ term (e.g. the *Someplace Granite*). However, the ‘key’ information relating to a lower-rank nonstratiform unit arguably can include its geographical location, lithological character, form type, style of spatial distribution and rank, and this breadth of information cannot be conveyed within a bipartite name. Formal names for lower-rank nonstratiform units therefore should be tripartite, comprising a geographical component, a lithological component and a unit term that conveys both their rank and form type or style of spatial distribution. Higher-rank units generally group numerous related bodies, which typically will display a broad range of characteristics that cannot be conveyed meaningfully in a name (i.e. lithological components, form types and types of spatial distribution). Thus, formal names for higher-rank units can more often be bipartite, comprising just a geographical component and a unit term.

**BRUCS: the BGS Rock Unit Classification System**

The BGS has created a new scheme for classifying and naming nonstratiform rock units that takes into account all of the key requirements described above. The key features of the new scheme (i.e. the hierarchical arrangement and unit types) are shown in Figure 2, alongside the well-established hierarchy for classifying stratiform bodies. Succinct definitions for the unit types associated with each of the new hierarchies are provided in Tables 1–3. The term ‘related’ is used in these tables, and hereafter, to refer to situations where a genetic relationship between units is established or inferred.

The ‘unified’ configuration presented in Figure 2 forms the basis of the BGS Rock Unit Classification System (BRUCS), which provides a flexible and practical means of classifying and naming all (stratiform and nonstratiform) mappable rock bodies. BRUCS has been designed with the geology of the UK in mind; however, it should be applicable to any setting, and particularly to those situations where the resolution of mapping and level of geological understanding together allow a full and detailed classification across multiple ranks.

Examples of how BRUCS has been, and could be, used to classify nonstratiform units are presented in Figures 3–10. Each of these figures is presented as a ‘classification grid’, with individual ranks extending from top to bottom, individual parent–child chains from left to right, and box colour denoting unit class (intrusion, tectonometamorphic, etc.). No stratigraphic or tectonostratigraphic order is implied by the way units are arranged in these figures; they merely illustrate the hierarchical relationships between units. An extended caption for each figure provides the necessary geological background and relevant details of how BRUCS has been applied in each example.

BRUCS has been used within the BGS to create a full classification of most of the Phanerzoic intrusions of the UK (*Gillespie et al.* 2012). These intrusions, which number many tens of thousands, formed in association with three major tectonothermal episodes. The units occupying ranks 1–3 of the classification relating to each episode are shown in Figure 3, and the full parent–child chains for two of the component units, the *Lake District Suite* and *Skye Central Complex*, are presented in Figures 4 and 5. The BGS is in the process of creating similar classifications for all other
Table 1. Definitions for unit terms in the hierarchy for intrusions

<table>
<thead>
<tr>
<th>Unit term</th>
<th>Rank</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centre</td>
<td>4</td>
<td>A group of two or more related units of lower rank focused tightly around a central point and usually intersecting to some degree</td>
</tr>
<tr>
<td>Cluster</td>
<td>4</td>
<td>A group of two or more related units of lower rank, associated spatially but not focused tightly</td>
</tr>
<tr>
<td>Cone-sheet</td>
<td>6</td>
<td>A sheet with a cone shape that dips inwards towards a central ‘focal’ point</td>
</tr>
<tr>
<td>Diatreme</td>
<td>6</td>
<td>A pipe filled with volcanic breccia that is inferred to form through gaseous disruption</td>
</tr>
<tr>
<td>Dyke</td>
<td>6</td>
<td>A sheet emplaced along a steep to vertical fracture, normally discordant to host-rock structure</td>
</tr>
<tr>
<td>Intrusion</td>
<td>6</td>
<td><em>Sensu lato:</em> any rock body formed when magma solidifies before reaching the surface. As a unit term in Rank 6: any intrusion whose form is not known or does not conform to one of those denoted by another unit term</td>
</tr>
<tr>
<td>Laccolith</td>
<td>6</td>
<td>An intrusion <em>sensu lato</em> that is roughly circular in plan, generally with a planar floor and domed roof</td>
</tr>
<tr>
<td>Lopolith</td>
<td>5</td>
<td>An intrusion <em>sensu lato</em> that is kilometre-scale or larger and broadly saucer-shaped</td>
</tr>
<tr>
<td>Neck</td>
<td>6</td>
<td>A pipe inferred to have fed a volcano, now infilled with collapsed material from the <em>vent</em></td>
</tr>
<tr>
<td>Pipe</td>
<td>6</td>
<td>An intrusion <em>sensu lato</em> that is cylindrical and normally steeply oriented</td>
</tr>
<tr>
<td>Plug</td>
<td>6</td>
<td>A pipe inferred to have fed a volcano, but generally lacking collapsed material from the <em>vent</em></td>
</tr>
<tr>
<td>Pluton</td>
<td>5</td>
<td>An intrusion <em>sensu lato</em> that is kilometre-scale or larger, and cylindrical, lenticular or tabular</td>
</tr>
<tr>
<td>Ring-dyke</td>
<td>6</td>
<td>A <em>sheet</em> that is arcuate or annular in plan, and usually vertical or inclined steeply outwards</td>
</tr>
<tr>
<td>Ring-intrusion</td>
<td>5</td>
<td>An intrusion <em>sensu lato</em> that is emplaced within, or bounded by, a ring-fracture</td>
</tr>
<tr>
<td>Sheet</td>
<td>6</td>
<td>An intrusion <em>sensu lato</em> with broadly parallel margins and one dimension much shorter than the other two</td>
</tr>
<tr>
<td>Sill</td>
<td>6</td>
<td>A <em>sheet</em> emplaced along a gently inclined to horizontal fracture; normally broadly concordant in strata</td>
</tr>
<tr>
<td>Subsuite</td>
<td>3</td>
<td>A group of two or more units of lower rank that display shared characteristics and belong to the same <em>suite</em></td>
</tr>
<tr>
<td>Suite</td>
<td>2</td>
<td>A group of two or more related units of lower rank</td>
</tr>
<tr>
<td>Supersuite</td>
<td>1</td>
<td>A group of two or more related <em>suites</em> with or without other units of lower rank that are not part of those <em>suites</em></td>
</tr>
<tr>
<td>Swarm</td>
<td>5</td>
<td>A group of two or more related units of lower rank that are spatially associated</td>
</tr>
<tr>
<td>Vein</td>
<td>6</td>
<td>An intrusion <em>sensu lato</em> that is sheet-like, but generally narrower and less regular than a <em>sheet</em></td>
</tr>
<tr>
<td>Vent</td>
<td>6</td>
<td>An opening at Earth’s surface through which volcanic material has been, or is being, extruded</td>
</tr>
</tbody>
</table>

Table 2. Definitions for unit terms in the hierarchy for tectonometamorphic units

<table>
<thead>
<tr>
<th>Unit term</th>
<th>Rank</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assemblage</td>
<td>2</td>
<td>A group of two or more related units of lower rank</td>
</tr>
<tr>
<td>Block</td>
<td>6</td>
<td>A unit with rectilinear boundaries that does not conform to the description of a <em>layer</em></td>
</tr>
<tr>
<td>Layer</td>
<td>6</td>
<td>A unit that is tabular, with parallel or near-parallel (co-planar) bounding surfaces</td>
</tr>
<tr>
<td>Lens</td>
<td>6</td>
<td>A unit that is broadly lensoidal</td>
</tr>
<tr>
<td>Ophiolite</td>
<td>4</td>
<td>A unit formed of obducted oceanic crust, traditionally recognized as several layers of ultrabasic and basic igneous rock, dykes and other intrusions, pillow lavas and sea-floor sediments, with or without subjacent mantle</td>
</tr>
<tr>
<td>Package</td>
<td>4</td>
<td>A group of two or more related units of lower rank that are essentially contiguous at outcrop</td>
</tr>
<tr>
<td>Parcel</td>
<td>5</td>
<td>A group of two or more related units of lower rank that are essentially contiguous at outcrop</td>
</tr>
<tr>
<td>Set</td>
<td>4</td>
<td>A group of two or more related units of lower rank that are essentially dispersed (not contiguous) at outcrop</td>
</tr>
<tr>
<td>Subassemblage</td>
<td>3</td>
<td>A group of two or more related units of lower rank that display shared characteristics and belong to the same <em>assemblage</em></td>
</tr>
<tr>
<td>Superassemblage</td>
<td>1</td>
<td>A group of two or more related <em>assemblages</em> with or without other units of lower rank that are not part of those <em>assemblages</em></td>
</tr>
<tr>
<td>Swarm</td>
<td>5</td>
<td>A group of two or more related units of lower rank that are essentially dispersed (not contiguous) at outcrop</td>
</tr>
<tr>
<td>Train</td>
<td>5</td>
<td>A group of two or more related units of lower rank that are essentially dispersed (not contiguous) and have a broadly linear disposition at outcrop</td>
</tr>
</tbody>
</table>

Table 3. Definitions for unit terms in the hierarchy for mixed-class units

<table>
<thead>
<tr>
<th>Unit term</th>
<th>Rank</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central complex</td>
<td>3</td>
<td>A unit comprising multiple related intrusions, usually with screens and irregular masses of associated extrusive rocks and/or country rocks, and commonly but not necessarily arranged spatially around one or more focal points. <em>Central complexes</em> are commonly composed of two or more spatially associated (and commonly intersecting) <em>centres</em>, and may generally be considered to represent the roots of a central volcano at a relatively shallow crustal level; however, that association is not essential to this definition</td>
</tr>
<tr>
<td>Complex</td>
<td>2</td>
<td>A group of two or more related units of lower rank</td>
</tr>
<tr>
<td>Ring-complex</td>
<td>4</td>
<td>A unit comprising multiple <em>ring-intrusions</em> and/or <em>ring-dykes, cone-sheets, ring-dyke-swarms and cone-sheet-swarms</em>, and their country-rock</td>
</tr>
<tr>
<td>Sheet-complex</td>
<td>4</td>
<td>A unit comprising multiple <em>sheets</em> and their country-rock</td>
</tr>
<tr>
<td>Sill-complex</td>
<td>4</td>
<td>A unit comprising multiple <em>sills</em> and their country-rock</td>
</tr>
<tr>
<td>Subcomplex</td>
<td>3</td>
<td>A group of two or more units of lower rank that display shared characteristics and belong to the same <em>complex</em></td>
</tr>
<tr>
<td>Supercomplex</td>
<td>1</td>
<td>A group of two or more related units of lower rank</td>
</tr>
<tr>
<td>Vein-complex</td>
<td>4</td>
<td>A unit comprising multiple <em>veins</em> and their country-rock, the whole being typically intermediate in character between a xenolith-rich <em>intrusion (sensu lato)</em> and veined country-rock</td>
</tr>
<tr>
<td>Volcano-complex</td>
<td>3</td>
<td>A unit comprising all the related units, extrusive, intrusive and sedimentary, formed at a site of persistent volcanic activity</td>
</tr>
</tbody>
</table>
nonstratiform units of the UK, and work is ongoing to incorporate the new hierarchical relationships and unit names into BGS databases and digital products.

In practice, formal unit names are likely to be assigned only to the larger or more important mapped bodies, and to some bodies that are too small to map but are well known or geologically significant (e.g. a thin but richly mineralized band in a layered intrusion). Although they can be classified, many smaller mappable bodies, and nearly all unmapped bodies, may never be assigned a name, in which case their presence ideally should be recorded; for example, in the description of their immediate parent unit (e.g. ‘the Someplace Basalt Dyke-swarm consists of numerous dykes that have not been mapped or named individually’). Examples of how unnamed units can be acknowledged in classification grids are provided in Figures 4–10.

The key features and principles of BRUCS are as follows (see also Fig. 2).

- Stratiform and nonstratiform bodies are treated separately.
- Three categories of single-class unit are recognized, based on their genesis: accumulated units, intrusions and tectono-metamorphic units. Each category has its own set of unit terms arranged in a hierarchy of up to six ranks. Mixed-class units have their own hierarchy, which of necessity spans fewer ranks.
- Accumulated units are bodies formed by processes that cause geological materials to accumulate at Earth’s surface, such...
as deposition, effusion and evaporation. They are generally stratiform and typically form successions. They should be classified and named using the well-established hierarchy and procedure for lithostratigraphic units that is advocated in the ISG (ISSC 1994).

- **Intrusions** are rock bodies formed when magma solidifies in the subsurface. Bodies that may have formed *in situ*, and as such may not have been intruded *sensu stricto*, are included.

- **Tectonometamorphic units** are rock bodies that cannot reliably be classified as an accumulated unit or an intrusion as a result of superimposed deformation and/or metamorphism.
  - Those resulting primarily from deformation include allochthonous bodies in thrust zones and new bodies formed in shear zones through intense tectonic interleaving; such bodies are defined by discrete, high-strain boundaries (a focus for either brittle or ductile deformation), and have become physically separated from their original geological context by displacement associated with those boundaries. Some of these units will contain or consist of rocks in which primary stratification or original intrusion form are still discernible and can be mapped; in many cases, it will be possible to relate these stratiform bodies or intrusions to their original geological context, but where that is not possible the host tectonometamorphic unit can be described as *isolated*.
  - Those resulting primarily from metamorphism have been modified by that metamorphism to the extent that the original unit category (e.g. accumulated unit or intrusion), and/or the nature of the original relationship with adjacent units (unconformable, depositional, intrusive or structural), cannot be deduced or inferred reliably. High-grade gneiss terranes, such as the Lewisian rocks of NW Scotland, generally contain many such tectonometamorphic units.

- **Intrusions and tectonometamorphic units are referred to collectively as morphogenetic units**, to reflect the two key criteria (form/morphology and genesis) used to classify them.

- **Formal classification takes place within the six ranks of Figure 2**, and using the unit terms therein. Any other terms, including those that connote a subdivision of an individual intrusion (e.g. ‘facies’ and ‘zone’) or a large-scale grouping of units (e.g. ‘province’), must not be used in the parent–child chain of a formal classification.

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<table>
<thead>
<tr>
<th>Rank 6</th>
<th>Rank 5</th>
<th>Rank 4</th>
<th>Rank 3</th>
<th>Rank 2</th>
<th>Rank 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>unnamed silts</td>
<td>undefined sill-swarm</td>
<td>Borrowdale Sill Cluster</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>unnamed plugs and sheets of microdiorite</td>
<td>Embleton Microdiorite Plug-and-sheet-swarm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dash Hornblende Plug</td>
<td>Bassenthwaite Microdiorite Plug-and-intrusion-swarm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>unnamed Intrusions of microdiorite</td>
<td>Pike de Bield Andesite Swarm</td>
<td></td>
<td></td>
<td></td>
<td>Derwent Mafic Minor Intrusion Cluster</td>
</tr>
<tr>
<td>unnamed dykes of basalt</td>
<td>Wastdale Basalt Dyke-swarm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wallow Crag Gabбро Plug</td>
<td>Haweswater Gabбро-microdiorite Plug-and-dyke-swarm</td>
<td></td>
<td></td>
<td></td>
<td>Caledonian Supersuite (encompasses other child units)</td>
</tr>
<tr>
<td>Naddle Beck</td>
<td>Carrock Gabбро-gabbro-pluton</td>
<td>Carrock Fell Centre</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dolerite Plug</td>
<td>Cumbrian Mountains Felsic Subsuite</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Birkhouse Hill Microdiorite Plug</td>
<td>Mosedale Gabбро Pluton</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>unnamed plugs and dykes</td>
<td>Carrock Gabбро-gabbro-pluton</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harestones</td>
<td>Carrock Gabbro-pluton</td>
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<tr>
<td>Rhylite Intrusion</td>
<td>Eeskdale Granite Pluton</td>
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<td></td>
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</tr>
<tr>
<td>Red Covercloth</td>
<td>Broad Oak Granodiorite Pluton</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microgranite Intrusion</td>
<td>Emmerdale Granite Pluton</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rae Crags Granite Intrusion</td>
<td>West Water Felsic Dyke-swarm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miton Hill Microgabbro Intrusion</td>
<td>Wensleydale Granite Pluton</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buck Kirk Quartz-gabbro Intrusion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White Crags Gabбро Intrusion</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Black Crag Gabбро Intrusion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>unnamed dykes of felsic rock</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thrakfeld Microgranite Intrusion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>unnamed minor intrusions of microgranite and microgranodiorite</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Fig. 4. Classification of the Lake District Suite, northern England, using BRUCS. Colours denote unit class (see Fig. 2). The Lake District Suite is a component of the Caledonian Supersuite.**

The classification shown here is based on Millward (2002). All classified components of the suite are intrusions. A subset of the units encompassed by the suite is grouped within a subsuite, the Cumbrian Mountains Felsic Subsuite, at Rank 3. Other units of lower rank are grouped within three units, two clusters and a centre, at Rank 4. Two plutons in the Carrock Fell Centre, the Carrock Gabбро–granite Pluton and Mosedale Gabбро Pluton, encompass two or more mappable intrusions that are classified and named at Rank 6. Many of the smaller mappable units classified at Rank 6 are currently unnamed.
The smallest mappable morphogenetic units are delimited by their geological boundary and classified in the lowest rank of their hierarchy (Rank 6), primarily according to their 3D form (observed or inferred). Pluton, lopolith and ring-intrusion, each of which can be essentially one intrusion, are placed at Rank 5 because they can also consist of two or more discrete mappable intrusions that would be classified at Rank 6.

Groups of related morphogenetic units are defined and classified by their spatial and genetic relationships at ranks 5 and 4, and by genetic relationship alone in higher ranks. Information based on genetic interpretations should be used judiciously in classification, especially in those circumstances where a mature understanding of such relationships has not yet become established.

The size of a mappable body is irrelevant in determining the rank at which it should be classified. A dyke is classified at Rank 6 regardless of whether its outcrop is 10 m or 100 km long, and a parcel is classified at Rank 5 regardless of whether its outcrop covers 1 km$^2$ or 1000 km$^2$.

The number of units in a group of related units is irrelevant in determining the rank at which it should be classified. For example, two or any larger number of dykes can be grouped within a dyke-swarm.

A specific ‘entry point’ for classification, equivalent to the role played by formation in classifying a stratiform succession, and a preferred ‘direction of travel’ within a hierarchy (i.e. bottom-up or top-down) are not prescribed for morphogenetic units and mixed-class units, but are left to the geologist’s discretion. In deciding how to proceed with classification in any particular area, geologists will need to account for the state of existing mapping and knowledge, the time and resources available to gather new information, and the overall objectives of the work in hand. In poorly understood or geologically complicated ground, or if the goal is simply a reconnaissance-level survey, classification may begin in, and be limited to, the mid- to high ranks, with refinement and expansion into other ranks happening subsequently as new information becomes available.

A classified unit does not need to have a related ‘parent’ or ‘child’ unit in any other rank. For example, a unit could be classified at Rank 5, with no parent or child at any other rank, either because it actually has no known ‘relatives’ or because its relationship with other units is unknown or uncertain. It is also acceptable for a parent–child relationship to skip one or more ranks. For example, two or more plutons (Rank 5) may be grouped within a suite (Rank 2), with no ‘relatives’ in intervening ranks.

---

### Table: Classification Grid

<table>
<thead>
<tr>
<th>Rank 6</th>
<th>Rank 5</th>
<th>Rank 4</th>
<th>Rank 3</th>
<th>Rank 2</th>
<th>Rank 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meall Dearg Basic Intrusion-broccoli Pipe</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coire Uaigneach Granite Intrusion</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Gars-a-hnein Pendolite Sill</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Cuillin Centre</td>
</tr>
<tr>
<td>Garbh-choire Pendolite Intrusion P1</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Garbh-choire Pendolite Intrusion P2</td>
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<tr>
<td>Garbh-choire Pendolite Intrusion P3</td>
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<tr>
<td>Garbh-choire Pendolite Intrusion P4</td>
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<tr>
<td>Garbh-choire Pendolite Intrusion P5</td>
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<td>Garbh-choire Pendolite Intrusion P6</td>
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<td></td>
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<td>Skye Central Complex</td>
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<td>Hebrides Subvolcanic Suite (encompasses other child units)</td>
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<td></td>
<td>Atlantic Super-suite (encompasses other child units)</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td>Fionn Choire Formation</td>
</tr>
<tr>
<td>Biaven Granite Intrusion</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Ruadh Slac Granite Intrusion</td>
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<td></td>
</tr>
<tr>
<td>Meall Dearg Granite Intrusion</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Srath na Creitheach Centre</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Srath na Creitheach Formation</td>
</tr>
</tbody>
</table>

(Cont. below)

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However, any unit classified as a *subsuite* or *subassemblage* (at Rank 3) must have a parent at Rank 2.

- Formal names for units classified at ranks 6 and 5 are generally tripartite, comprising a geographical term, lithological term and unit term, in that order; for example, the *Cairngorm Granite Pluton*. Although such names can be relatively cumbersome, they are informative and can be presented in a shortened form (e.g. *Cairngorm pluton*).

- Geographical terms should be unique (not used in more than one unit name), so that shortened names are also unique.

- The requirements for providing formal descriptions and achieving formal status for all units classified using BRUCS are essentially the same as those required for lithostratigraphic units in the ISG; for example, descriptions should include details of lithological character, boundary character, and hierarchical relationships (parent unit and child units, where appropriate) and details of a type locality.

**Classifying and naming intrusions**

**Classification at ranks 6, 5 and 4.** Thirteen types of intrusion are placed at Rank 6 of the intrusions hierarchy (Fig. 2 and Table 1). Eight, *cone-sheet, dyke, laccolith, pipe, ring-dyke, sheet, sill* and *vein*, are distinguished purely on the basis of their form (e.g. "Cairngorm pluton") once the formal name has been introduced and defined. Three, *diatreme, neck* and *plug*, include in their definition an element of setting or genesis. One, *vent*, connotes a setting but not a specific form, and one, *intrusion*, carries no connotation of shape, setting or genesis (other than that it is an intrusion), but may be used to classify a unit at Rank 6 whose form is not known or that is not one of the other unit types at Rank 6.

Four unit types are placed at Rank 5. Related and spatially associated units classified at Rank 6 can be grouped at Rank 5 in a *swarm*. The term can be used on its own in this context but can be
made more informative by concatenation with one or more of the unit terms from Rank 6. Thus, a group of dykes is a *dyke-swarm*, and a group of cone-sheets is a *cone-sheet-swarm*. Longer names may be constructed to denote related groups of more than one type of intrusion (e.g. *dyke-and-sill-swarm*); such names are not shown in Figure 2, or included in Table 1, but many such combinations are possible. The three other unit types at this rank, *pluton, lopolith and ring-intrusion*, are for bodies that can consist of a single intrusion or multiple intrusions (i.e. they can be ‘simple’ or ‘composite’); placing them at Rank 5 means that the individual intrusions in a composite pluton, for example, can be classified at Rank 6. The definitions for pluton and lopolith include a lower size limit to ensure the terms are reserved for relatively large intrusions (Table 1).

Rank 4 contains two types of unit, *centre* and *cluster*, that can group units of lower rank in a way that conveys a particular spatial as well as a genetic relationship. A *centre* encompasses units that spatially are tightly focused around a central point, and a *cluster* encompasses units that are associated spatially but not tightly focused (i.e. are more scattered than those forming a centre). A *centre* could, for example, comprise two intersecting plutons, and several ring-dykes, a dyke-swarm and a number of pipes that intersect the plutons or are spatially closely associated with them. A *cluster* might consist of two dyke-swarms, a sill-swarm and numerous pipes, which are related but scattered over a wide area.

Figures 4 and 5 include examples of how BRUCS has been used to classify and name many of these unit types at ranks 6, 5 and 4.

**Classification at ranks 3, 2 and 1.** The three highest ranks of the intrusions hierarchy each contain only one unit type, which in each case is used to group two or more units of lower rank. At these high ranks, the unit terms carry no connotation of form type or spatial relationship, but simply imply an inferred genetic relationship.

Figures 3–5 include examples of how BRUCS has been used to classify and name units in these higher ranks. Where a higher rank classification is appropriate, a group of related units from ranks 6, 5 and 4 should first be classified at Rank 2 as a *suite*. This term has been used widely in the past to refer to groups of related rock bodies (usually, but not always, intrusions), although definitions vary. As defined here, ‘suite’ is used simply to group related intrusions of lower rank; these must be inferred to have some degree of genetic relationship but need not be comagmatic.

A subset of the units in a suite may be grouped within a *subsuite*, at Rank 3, if they display shared characteristics and it is useful to distinguish them in this way. A subsuite can be identified only after its ‘parent’ suite has been defined. Not all suites will contain a subsuite, and there is no requirement to group all the units in a suite into subsuites. A suite could, for example, consist of a subsuite of three plutons and several other units not assigned to a subsuite. Two or more related suites, with or without other units of lower rank that are not part of those suites, may be grouped within a *supersuite*.

**Nomenclature at ranks 6 and 5.** Formal names for units classified at ranks 6 and 5 should consist of a geographical term, a lithological term and a unit term, in that order (e.g. *Eskdale Granite Pluton*). The geographical term should refer to a district, settlement or feature within, or adjacent to, the outcrop of the unit. The lithological term should convey the essential character of the unit as accurately as the concise format allows. Two rock name terms linked by an *en dash* (–) may be used where units have two important lithological components, or to indicate the principal end-members in a unit characterized by lithological diversity (e.g. *Comrie Diorite-granite Pluton*). In BGS databases and products, all of the lithological terms used in unit names must be consistent with the definitions in the BGS Rock Classification Scheme (Gillespie and Styles 1999; Hallsworth and Knox 1999; Robertson 1999). The unit term (e.g. plug, dyke, pluton) should be selected from an appropriate rank of the hierarchy.

**Nomenclature at ranks 4, 3 and 2.** The names of units classified at these ranks should consist of a geographical term and a unit term (e.g. *Carrock Fell Centre* and *Shetland Suite*). Terms to indicate other characteristic or distinctive features of a unit (e.g. its broad compositional character (mafic, alkaline, etc.), chronostratigraphic division or the typical 3D form of its constituent units) can be inserted between the two principal components of the name to help distinguish one unit from another in areas where multiple units have overlapping extents and/or suitable geographical terms are at a premium. Chronostratigraphic terms have been inserted in the names *Scottish Highlands Ordovician Suite* and *Scottish Highlands Silurian Suite* to address such a situation in the UK (Fig. 3).

**Classification at Rank 1.** Supersuites should be assigned a bipartite name consisting of a term to indicate the tectonothermal episode with which the magmatism is associated, followed by the unit term *supersuite*; thus, the name *Caledonian Supersuite* (e.g. Fig. 3) denotes a Rank 1 unit that embraces all of the intrusions that formed in association with the Caledonian Orogeny.

**Classifying and naming tectonometamorphic units**

**Classification at Rank 6.** Four unit types at Rank 6 are distinguished by their form (Fig. 2): *lens* and *layer* are units that approximate to lensoidal and tabular form, respectively, a *block* has rectilinear boundaries but is not tabular, and a *mass* is a unit whose character is not well described by any of these terms, or is unknown.

Definitions of these unit terms, and of those in higher ranks of the hierarchy for tectonometamorphic units, are provided in Table 2.

**Classification at ranks 5 and 4.** Two or more tectonometamorphic units classified at Rank 6 may be united within one of three unit types at Rank 5, according to the nature of their spatial relationship (Fig. 2): *train* and *swarm* denote dispersed associations, the former in a broadly linear arrangement, whereas *parcel* denotes a contiguous association. Where appropriate, terms from Rank 6 and Rank 5 can be linked to make compound unit terms like *block-train* (a train consisting largely or entirely of blocks) and *lens-swarm*; such names are not shown in Figure 2, or included in Table 2, but several such combinations are possible. Two or more units classified at Rank 6 and/or 5 may be united within one of two unit types at Rank 4, also according to the nature of their spatial relationship; *set* denotes a dispersed association, whereas *package* denotes a contiguous association.

**Ophiolite,** a fragment of obducted oceanic crust (e.g. Dewey 1976), is a specific type of isolated tectonometamorphic unit classified at Rank 4 (Fig. 2). Classic examples of ophiolite have a mixed-class character in lithological terms, typically comprising several layers of ultrabasic and basic igneous rock, ‘sheeted’ dykes and other intrusions, with pillow lavas and sea-floor sediments (e.g. Morag et al. 2016; Guilmette et al. 2018). However, the lithological character of an ophiolite (prior to any alteration) derives from its pre-obduction setting (i.e. autochthonous oceanic crust), whereas the mapped boundary of an ophiolite derives from the later tectonic process of obduction; thus, for the purposes of classification, ophiolite is considered to be a tectonometamorphic unit with a particular lithological character and structural history. Not all of the lithological components listed above need be present to classify a unit as ophiolite, but there must be enough evidence to support an interpretation that the body in question represents former oceanic crust. Any mappable bodies within an ophiolite unit can be classified as child units of the parent, and named using lower-rank unit terminology from the hierarchy for tectonometamorphic units;
for example, Someplace Peridotite Layer, Someplace Basalt Sheeted-dyke Swarm and Someplace Metamudstone Layer. The Rank 4 position allows individual related occurrences of ophiolite to be grouped in higher-rank associations.

Figures 6, 8, 9 and 10 include examples of how BRUCS has been used to classify and name many of the types of lower-rank tectonometamorphic units.

Classification at ranks 3, 2 and 1. In common with the other hierarchies for single-class units, the three highest ranks of the hierarchy for tectonometamorphic units each contain only one unit type, which in each case is used to group two or more units of lower rank (Fig. 2). At these higher ranks, the unit terms carry no connotation of form type or spatial relationship, but simply imply an inferred genetic relationship. Where classification at a higher rank is appropriate, a group of related units from ranks 6, 5 or 4 should first be classified at Rank 2 as an assemblage. A subset of the units in an assemblage may be grouped within a subassemblage, at Rank 3, if they display shared characteristics and it is useful to distinguish them in this way. A subassemblage can be identified only after its ‘parent’ assemblage has been defined. Not all assemblages will contain a subassemblage, and there is no requirement to group all the units in an assemblage into subassemblages. Two or more related assemblages, with or without other units of lower rank that are not part of those assemblages, may be grouped within a superassemblage.

### Table: Classification of the Glencoe Caldera Volcano-complex, Scotland, using BRUCS

<table>
<thead>
<tr>
<th>Rank 6</th>
<th>Rank 5</th>
<th>Rank 4</th>
<th>Rank 3</th>
<th>Rank 2</th>
<th>Rank 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>several named beds</td>
<td>Dalness Ignimbrite Member</td>
<td>Glencoe Caldera Volcano-complex</td>
<td>Scottish Highlands Silurian Suite (encompasses other child units)</td>
<td>Caledonian Supersuite (comprises other child units)</td>
<td></td>
</tr>
<tr>
<td>several unnamed flows of andesite</td>
<td>Bidein nam Bian Andesite Member</td>
<td>Glencoe Volcanic Formation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>several unnamed beds</td>
<td>Glas Choire Sandstone Member</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>unnamed flows of andesite, with intercalated sediment and subordinate intrusions</td>
<td>Upper Streaky Andesite Member</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>several named beds</td>
<td>Three Sisters Ignimbrite Member</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>unnamed flows of andesite with subordinate intrusions</td>
<td>Lower Streaky Andesite Member</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>several named beds and flows</td>
<td>Elive Rhyolite Member</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>unnamed sills of andesite</td>
<td>Achtriochlan Andesite Sill-swarm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>unnamed intrusions of gabbro, diorite, tonalite, monzonite &amp; granite</td>
<td>Glencoe Gabbro–granite Intrusion-swarm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>unnamed sheets of andesite</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 7. Classification of the Glencoe Caldera Volcano-complex, Scotland, using BRUCS. Colours denote unit class (see Fig. 2). The classification shown here is based on BGS (2005b). The Glencoe Caldera Volcano-complex (Rank 3) is a component of the essentially intrusive Scottish Highlands Silurian Suite (Rank 2), which in turn is a component of the Caledonian Supersuite (Rank 1). The volcano-complex is a mixed-class unit encompassing: (1) a stratiform unit at Rank 4 (the Glencoe Volcanic Formation), which has numerous named and unnamed child units at ranks 5 and 6; and (2) numerous intrusions, including two named units at Rank 5 and numerous unnamed ones at Rank 6.
Figures 8, 9 and 10 include examples of how BRUCS has been used to classify and name some of these higher-rank tectonometamorphic units.

Nomenclature at ranks 6 and 5. Formal names for tectonometamorphic units classified at ranks 6 and 5 should consist of a geographical term, a lithological term and a unit term, in that order (e.g. Scouriemore Metagabbro Mass; Fig. 8). The geographical term should refer to a district, settlement or feature within, or adjacent to, the outcrop of the unit. The lithological term should convey the essential character of the unit as accurately as the concise format allows. Two rock name terms linked by an en dash (‒) may be used where units have two important lithological components, or to indicate the principal end-members in a unit characterized by lithological diversity (e.g. Tarbet Psammite‒quartzite Layer-parcel; Fig. 8). In BGS databases and products, all of the lithological terms used in unit names must be consistent with the definitions in the BGS Rock Classification Scheme (Gillespie and Styles 1999; Hallsworth and Knox 1999; Robertson 1999). The unit term (e.g. layer, lens-parcel) should be selected from an appropriate rank of the hierarchy.

Classifying and naming mixed-class units
A mappable entity that encompasses multiple bodies of more than one genetic class, such that its essential character is of ‘mixed’ genetic class, should be classified using the hierarchy for mixed-class units (Fig. 2). This hierarchy will usually be used in two situations.

- Where it is impractical or undesirable to map or distinguish the smallest mappable bodies. This can be the case in, for example, a reconnaissance-level survey of geologically complicated ground, or where numerous small bodies of one class cut a ‘host’ body of another (e.g. a sill-swarm emplaced in a stratiform succession).
- Where it is useful to unite, in a single entity, rock units of two or more classes that display a close natural association. Examples include the conjunction of intrusive, extrusive and sedimentary rocks that commonly forms in volcanic settings (e.g. the Glencoe Caldera Volcano-complex; Fig. 7), and the intimate juxtaposition of metasedimentary and metagneous bodies commonly found in basement gneiss terranes (e.g. the Lewisian Supercomplex; Fig. 8).

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Nomenclature at ranks 4 to 1. The names of units classified at these ranks should consist of a geographical term and a unit term (e.g. Shetland Ophiolite and Menai Assemblage). Terms to indicate other characteristic or distinctive features of a unit can be inserted between the term and a modifying unit term. Examples include the conjunction of intrusive, extrusive and sedimentary rocks that commonly forms in volcanic settings (e.g. the Glencoe Caldera Volcano-complex; Fig. 7), and the intimate juxtaposition of metasedimentary and metageneous bodies commonly found in basement gneiss terranes (e.g. the Lewisian Supercomplex; Fig. 8).
Mixed-class units are inherently variable and often geologically complicated, and it is impractical to attempt to create a set of unit types that can account for all possible variations. In Figure 2, several specific types of mixed-class unit that occur in UK geology are included along with the three non-specific types subcomplex, complex and supercomplex; however, other specific types of mixed-class unit may need to be defined for work elsewhere. The variability of mixed-class units also means that the most appropriate rank at which to place the specific unit types may change in different settings; the arrangement shown in Figure 2 works well for UK geology but may not be ideally suited to other situations.

Each of the unit types subcomplex, complex and supercomplex, at ranks 3, 2 and 1 respectively, is used to group two or more units of lower rank (Fig. 2); these terms carry no connotation other than a mixed-class character and an inferred genetic relationship. As in the higher ranks of other hierarchies, a complex must be defined before a related subcomplex can be classified at Rank 3, and two or more related complexes, with or without other units of lower rank that are not part of those complexes, may be grouped in a supercomplex. However, it is not essential for a complex or a supercomplex to incorporate units of lower rank from the hierarchy for mixed-class units; they can incorporate related units from any hierarchy within Figure 2, provided the essential character of the resulting complex or supercomplex is ‘mixed class’. Figure 8 presents an example of a situation where a supercomplex consists entirely of units that have been classified in single-class hierarchies.

All of the specific types of mixed-class unit included in Figure 2 have a compound unit term that combines a term to convey the essential character or setting of the unit with the word ‘complex’. The unit term for each of the four mixed-class units at Fig. 8presents an example of a situation where a supercomplex consists entirely of units that have been classified in single-class hierarchies.
Two specific types of mixed-class unit are placed at Rank 3 alongside *subcomplex* (Fig. 2). A *central complex* is typically composed of two or more spatially associated (and commonly intersecting) *centres*, together with screens and irregular masses of associated extrusive rocks and country rocks. The term ‘central complex’ has previously been used in this sense to name rock units in the UK that are interpreted to be the eroded roots of Paleogene volcanoes (Emeleus and Bell 2005). Central complexes thus generally form in shallow subsurface settings, and as such are of highly variable character. Some have an unambiguously ‘mixed-class’ nature, whereas others may be dominated by units of one class (usually intrusions), in which case the mixed-class character is less obvious; the Skye *Central Complex* is an example of the latter situation (Fig. 5). A *volcano-complex* might contain all the related materials, extrusive, intrusive and sedimentary, formed at a site of persistent volcanic activity; the *Glencoe Caldera Volcano-complex* is an example (Fig. 7).

![Fig. 10. A possible re-classification of rock units within the Highland Border Fault Zone (HBFZ), central Scotland, using BRUCS. Colours denote unit class (see Fig. 2). (a) A representation of the state of knowledge and classification within the HBFZ prior to 2007; although it did not exist at the time, the units are shown within a six-rank hierarchy for ease of comparison with (b). At that time, the Highland Border Ophiolite was a rather poorly defined unit, and the stratiform units that are complexly interleaved with it were named (as formations) but not correlated with units outside the HBFZ. The degree of geological complexity within the zone, and state of geological understanding at the time, were such that all components were united within a single parent unit denoting a complicated association, the ‘Highland Border Complex’. (b) The units of the former ‘Highland Border Complex’, re-classified using BRUCS and taking into account the improved understanding obtained through detailed re-mapping of parts of the HBFZ by Tanner and Sutherland (2007). The stratiform units are now recognized as the youngest part of the *Dalradian Supergroup*, and placed in a new parent group (the *Trossachs Group*). The *Highland Border Ophiolite* is classified as a tectonometamorphic unit at Rank 4, uniting numerous child units all of which are likewise classified as tectonometamorphic units. The figure shows how the *Highland Border Ophiolite* might, in due course, be grouped with other fragments of Iapetus Ocean ophiolite (e.g. the *Ballantrae Ophiolite and Shetland Ophiolite Assemblage*) within a single parent, here named the *Iapetus Ocean Ophiolite Superassemblage*.

<table>
<thead>
<tr>
<th>Rank 6</th>
<th>Rank 5</th>
<th>Rank 4</th>
<th>Rank 3</th>
<th>Rank 2</th>
<th>Rank 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highland Border Complex</td>
<td>Highland Border Ophiolite</td>
<td>Trossachs Group</td>
<td>Dalradian Supergroup</td>
<td>(also encompasses numerous other child units)</td>
<td>Iapetus Ocean Ophiolite Superassemblage</td>
</tr>
<tr>
<td>Corrie Burn Schist</td>
<td>Lime Hill Serpentinite</td>
<td>North Esk Formation</td>
<td>Bohnside Slate Formation</td>
<td>Dounans Limestone Formation</td>
<td>Burn of Mar Sandstone Formation</td>
</tr>
</tbody>
</table>
| unnamed units of hornblende schist | Highland Border Ophiolite | tilted Basaltic Member | Keltie Water Grit Formation | Leivy Limestone and Slate Member | unnamed masses of hornblende schist
| | | | | | unnamed masses of serpentine |
| | | | | | unnamed masses of basaltic pillow lava |
| | | | | | unnamed masses of serpentine |
| | | | | | unnamed masses of basaltic pillow lava |

Nomenclature. Names assigned to mixed-class units should consist of a geographical term and a unit term (e.g. *Someplace Ring-complex*). However, a term that reflects the geological setting (e.g. *Glencoe Caldera Volcano-complex*) and/or established nomenclatural precedent (e.g. *Levisian Supercomplex*; Fig. 8) can be used instead of, or in addition to, the geographical term, where appropriate.
Practical considerations

Geological relationships can be complicated, so the following additional guidance addresses some general points not covered above, and includes some suggested practical solutions for special situations. Inevitably, common sense and pragmatism will often be needed alongside the scheme guidelines in deciding how best to classify and name mapped units.

(1) In general, units should be classified and named in a way that reflects their essential character. For example, not all of the units grouped within a package need be contiguous, but the essential character of a package should be of largely contiguous units. Similarly, a group of spatially associated sheet intrusions of which 90% are dykes and 10% are sills could be classified as a dyke-swarm (rather than a dyke-and-sill-swarm or a sheet-swarm), as that describes the essential character of the unit. Essential character can also be important in deciding which hierarchy to use when grouping units. In the UK, for example, multiple central complexes (each classified at Rank 2 in the hierarchy for mixed-class units) have been grouped at Rank 3 within a unit from the hierarchy for intrusions (in this case, within the Hebrides Subvolcanic Suite of the Atlantic Supersuite; see Fig. 3), rather than in a parent from the hierarchy for mixed-class units (complex or supercomplex), because their essential character when considered as a group (i.e. dispersed centres of localized magmatism) is represented and conveyed more effectively in this way. On a smaller scale, a pluton can enclose many mappable screens of sedimentary rock and still be classified as an intrusion rather than a mixed-class unit if its essential character remains that of an intrusion.

(2) Some units will contain within their mapped boundary smaller mappable bodies that are derived from units whose main outcrop (if it still exists) lies beyond the boundary of the host unit. For the purpose of this discussion, and following the familial phraseology used elsewhere, such units could be thought of as ‘adopted’ because they are now enclosed, or nearly enclosed, by one or more ‘host’ units at outcrop. In classification, such bodies should be treated as follows.

- Where it can be shown or reliably inferred that the adopted body and the host unit are related, both should be classified in the same parent–child chain. For example, a body of stratiform volcanic rocks that crops out within the boundary of a central complex that is otherwise dominated by intrusions should be classified as part of the central complex (i.e. in the same parent–child chain) if it is known or inferred to be a product of the same magmatism; the Fionn Choire Formation and Strath na Creitheach Formation of the Skye Central Complex are good examples (Fig. 5).
- Where it can be shown or reliably inferred that the adopted body and the host unit are not related, they should not be classified in the same parent–child chain. If the adopted body was derived from, or is still part of, a classified unit whose main outcrop is elsewhere, it retains the name assigned to the main outcrop; mappable screens of rock that are clearly derived from Lewisian Supercomplex country rocks but now occur as ‘adopted’ bodies within the outcrop of the Skye Central Complex are good examples. If the adopted body cannot be linked to a classified unit, it should not be classified within a parent–child chain but could be given an informal name if desired; a roof pendant or hanging wall of country rock that occurs as an adopted body within the outcrop of a pluton, and was derived from a body that no longer crops out elsewhere, is an example of such a situation.
- The most pragmatic way to classify some geological associations might require the creation of nonstandard parent–child relationships. The Moine Supergroup of NW Scotland (Fig. 9) contains good examples of situations where locally intense metamorphism has produced new mappable units of gneissose and/or migmatitic and/or igneous rock that occur within a regional-scale succession that generally can still be mapped and classified as stratiform. The original character and limits of some modified stratiform units may no longer be recognized with confidence, thus the new units are morphogenetic. It would be unhelpful and inappropriate to classify the parent body as a mixed-class unit where the proportion of morphogenetic units overall is very small and does not change the essentially stratiform character. It would also be unhelpful to classify the morphogenetic units formed within, and from, the parent body in a separate parent–child chain, as this might be taken to imply that they are unrelated. The pragmatic solution in this instance is to classify the main unit according to its essential (stratiform) character, and include at appropriate points within its parent–child chain some nonstratiform units. In Figure 9, the Sutherland Assemblage is a tectonometamorphic unit that is classified as a component of a much larger stratiform unit (the Moine Supergroup) in this manner. Figure 9 also shows an inverse version of this relationship, where several stratiform units (e.g. Scaraben Quartzite Formation) are classified within the Sutherland Assemblage; these units retain the essential character of stratiform units and their inclusion in the Sutherland Assemblage does not change its essential character as a tectonometamorphic unit.

(4) In some parts of the world, tectonic displacement has produced allochthonous sheets within regional-scale domains in which multiple related sheets are imbricated or ‘stacked’. The individual sheets within such domains can be of regional extent and kilometre-scale thickness, and they can consist of or contain multiple mappable stratiform units and/or intrusions. These create a significant problem for a hierarchical classification system like BRUCS, because whereas the allochthonous sheets are tectonometamorphic units, the mappable units they contain often are not. Each sheet conceivably could be thought of as a mixed-class unit. However, the tectonometamorphic ‘host’ (i.e. the allochthonous sheet) would have to be classified one rank (at least) above the highest rank needed to classify all of the stratiform units and/or intrusions mapped within it, and in many situations (especially those where the allochthonous sheet is just one of multiple related sheets that could also be classified hierarchically) there will be insufficient ranks within a single parent–child chain in which to classify all the related units.

In Norway, Sweden and Finland, where much of the bedrock geology consists of allochthonous sheets on a range of scales, this problem is addressed by classifying allochthonous sheets as a distinct category of unit, the tectonostratigraphic(al) unit, and classifying the stratiform units and intrusions within each sheet as ‘lithostratigraphical’ and ‘lithodeemic’ units respectively in separate hierarchies. A tectonostratigraphic unit in this context is ‘a generally flat-lying, scale-independent, tectonic unit that is bounded by zones of high strain’ (Kumpulainen 2017). In Norway, up to four ranks of tectonostratigraphic unit are recognized (Nystuen 1989): ‘nappe’ is the fundamental unit; ‘thrust sheet’ is one rank below nappe; ‘small thrust sheet’ is one rank below thrust sheet; and both ‘nappe complex’ and ‘nappe system’ are one rank above nappe. Finland and Sweden have adopted the same hierarchy and terms to varying degrees (Strand et al. 2010; Kumpulainen 2017).

Allochthonous sheets comprise just a small proportion of the UK bedrock, and no attempt has been made thus far to apply a robust tectonostratigraphic classification to them. Consequently, it is not clear if such an approach is needed, or is compatible with BRUCS, and BRUCS currently does not contain a hierarchy for tectonostratigraphic units. However, in parts of the world where the geology consists of regional-scale, stacked allochthonous sheets, and where it would be beneficial in terms of achieving the objectives of mapping and classification, it may be appropriate to use a hierarchy of tectonostratigraphic units (following the
New system for classifying and naming rock units  17

guidance used in Norway, Finland or Sweden) alongside those in BRUCS.

(5) In many areas, the classification process is likely to be piecemeal and iterative, and achieving a full, robust classification of nonstratiform units across all necessary ranks will require sufficiently detailed mapping and a considerable amount of research. In some cases, agreement on cross-border correlations may also be needed. When new information allows, the previously classified components of a tectonometamorphic unit, or a mixed-class unit in which the nature of the components had not been fully resolved, should be reclassified and renamed as stratiform units or intrusions as appropriate. This process might result in established unit names becoming diminished in importance, or even obsolete. One such example of an evolving classification is presented in Figure 10.

(6) The terminology used in BRUCS should not be confused with terrane nomenclature or used directly in terrane analysis, even where the extent of a classified unit (e.g. complex, supercomplex or supergroup) coincides wholly with a terrane, or where a terrane fulfils the criteria for a mixed-class unit. Stratiform and/or morphogenetic units may occur in more than one terrane but share in the distinct geological evolution of each. Indeed, a boundary between two complexes may be tectonic, intrusive or unconformable, but only in the first case could it qualify as a terrane boundary (e.g. Coney 1980).

Concluding remarks

A new scheme for classifying nonstratiform rock bodies (intrusions, tectonometamorphic units and mixed-class units) has been created to address a long-standing and significant deficiency in two previously published and widely used schemes for rock-unit classification, namely the International Stratigraphic Guide (ISG) and the North American Stratigraphic Code (NASC). The new scheme recognizes and reflects the distinctive geological characteristics of nonstratiform units, and the practices, needs and interests of geologists working with them. The importance of morphology and genesis in this classification, rather than lithological character and stratigraphic relationships, means that the new scheme differs fundamentally from those advocated in the ISG and NASC. Nevertheless, in terms of their basic design (a six-rank hierarchy) and taxonomic rigour, the new scheme for classifying nonstratiform bodies and the ISG scheme for classifying stratiform bodies are similar and complementary. The BGS Rock Unit Classification System (BRUCS) combines the two schemes to create a comprehensive, practical, robust and flexible means of classifying and naming all rock bodies at all normal mapping scales, in a manner that meets both the practical needs of researchers and the demands of the digital age. Although it has been designed with the geology of the UK in mind, BRUCS should be applicable to any setting, and particularly to situations where the resolution of mapping and the level of geological understanding together allow a full and detailed classification across multiple ranks. As with most attempts to systematize geology, BRUCS necessarily introduces some concepts and terms that geologists initially may find unfamiliar and perhaps peculiar; the authors would welcome feedback on its content and utility.

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Author contributions MBG: conceptualization (lead), methodology (equal), writing – original draft (lead); AGL: methodology (equal), writing – original draft (supporting).

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