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Symbols for Sedimentary Rocks

by

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ABSTRACT

The symbols representing sedimentary rocks should be based upon a practical lithologic classification and sound symbol design. Established symbols must be considered. Features not specifically related to rock types should be classed as accessory and separated from the main symbols, except for a few which are important to stratigraphic relationships. Only about twenty symbols are required to represent most rock types; recommended symbols are presented.

INTRODUCTION

Symbols must be clear, but there are a limited number of simple symbol designs and a large number of sedimentary rock types. Poorly defined symbols can confuse rather than clarify stratigraphic relationships. Apart from Bureau of Mineral Resources Circular #8, which presented symbols for maps, two symbol systems, by M.A. Condon and S. Nasr, are used within the Bureau. All three, and others, are considered.

A symbol system is required for columnar logs representing bore-hole or surface sections of sedimentary rocks. A single column is preferable to more than one. The amount of data shown on this column will vary, but all stratigraphic data cannot be shown on one column. However, in a good symbol system detailed data can be included in the main column when necessary.

SYMBOL MEANING

Data on sediments relate to lithology, textures, structures and rock genesis. Some megascopic features are unimportant to stratigraphic interpretation. Other features of major importance, are microscopic. Most symbols have to be abstract, regardless of the scale used or the amount of detail shown. Many common symbols are abstractions of lithological features. For example, dots for sandstone, lines for shale and bricks for limestone respectively suggest a granular texture, thin bedding, and thicker bedding with vertical joints. Established symbols can be accepted, unless there are very definite grounds for rejecting them. In carbonates, for example, there are a large number of genetic and textural types. The brick pattern is inadequate for representing these, but the symbol has world-wide acceptance, and rather than introduce new patterns for limestone sub-types the brick pattern should be retained as a symbol base. A second reason for doing this is that limestone interpretation varies with individuals. If different symbols are designated for say, sand grade limestone, oolites, and limestone generally, than three observers could show the same bed symbolically in three different ways. This also applies to clastic rocks. Different geologists could define the same bed as sandstone, lithic sandstone, arkose, greywacke, etc. If greatly different symbols are applied for every rock name, then in extreme cases logs of the same section by different authors could differ radically. This is unlikely to result in improved correlations. These points suggest that symbols should be based upon characteristics likely to be designated uniformly by all geologists, and that symbolic representation of more detailed features should be by variation of this basic symbol.

Representation of rock types can be accepted as the most important function of symbols on columnar logs. Any symbol system has to be related to lithologic classification for this reason. Classification involves the following parameters.

(i) Chemical. Chemical composition is related to mineralogical composition. The identification of carbonates is based on chemical composition.

(ii) Textural. Textures are determinate; they are important to the classification of clastics and to porosity.

(iii) Mineralogical. Most rock types are identified as being composed of specific mineral assemblages.

(iv) Genesis. Although rock genesis is of major importance in stratigraphic work it is always interpretative and not always determinable. In many cases the determination of genesis is the purpose behind symbolic representation and correlation, so it is impractical to base a symbol system on genesis.

The simplest classifications of sedimentary rocks emphasise (i) to (iii), and it is suggested that the following three-fold classificatory basis could be used for symbols:

(i) All terrigenous rocks can be shown by basic symbols for the clastic grade classes, i.e. clay, silt, sand, and coarser grade rocks. For example, marine orthoquartzites, aeolian sands, arkoses, greywacke, lithic sandstone, etc., would all be represented initially by the basic sand symbol.

(ii) Important sedimentary rocks such as carbonates, evaporites, coal and various organic deposits could also be allocated basic symbols.

(iii) All important diagenetic and metasomatic materials and all other specific minerals or rock types found in sediments can be allocated basic symbols. The mineral symbols allow finer representation of rock types in the first two categories, e.g. a feldspar symbol with a sandstone symbol would represent arkose.

SYMBOL SESIGN

Symbol design has to consider the following points:

(i) Standard symbols should be in black and white; colour involves difficulties in reproduction, fading, and cost.

(ii) Symbol patterns should be as simple as possible. Complex ones tend to be misinterpreted, miscopied, to reproduce indistinctly, and to require more drafting.

(iii) The most commonly used symbols should have the simplest design. Open or linear symbol patterns are less liable to block up and do not dominate the pattern, therefore are to be preferred to closed patterns.

(iv) Many rock types can be represented by mixtures of basic symbols. Symbols should be miscible to show such rocks with clarity, e.g. a dolomitic, argillaceous, silty, glauconitic sandstone.

(v) Symbols should be adaptable to expressing percentage representation for mixed lithologies. For example, it should be possible to indicate at least shale, slightly calcareous shale, calcareous shale, shaly limestone, slightly shaly limestone and limestone, and preferably other categories. This should also be practicable for rocks involving more than two basic symbols.

(vi) Contacts and bedding habit can be very important.

Symbols should be capable of indicating thick or thin bedding habit and sharp or intergrading contacts. Horizontally aligned symbols are most adaptable for these purposes.

(vii) Symbols can be shown in more than one vertical column on a stratigraphic log. If this is done ease of interpretation depends upon the relationship between data in the various columns. If they are unrelated or only distantly related, interpretation is not impaired. However, if interpretation of one column depends upon symbol data in another the overall interpretation will become less effective because the human eye and brain has to evaluate the intercolumn relationships and then relate this to the log as a whole. There is further loss of interpretation if two or more logs have to be correlated.

In detailed stratigraphic work there may be an abundance of observed data directly relating to the sediments, including estimates of mineralogical or compositional mixtures, genetic interpretation, grade size relationships, porosity percentages and types, grain roundness, sorting etc. These data are too voluminous to show in a single column, and the present tendency is to use multiple columns on which the data are plotted either symbolically or by block diagrams of various kinds. If such data are directly related to the lithology, however, symbols should be used which allow them to be shown on the main columnar log where this in considered desirable, instead of, or as well as, on parallel columns.

(viii) A large number of stratigraphic features not directly related to lithology can be important in correlation work. These include megatextural features like current bedding, and structural data like dips. It is possible to exclude most of these features from the main lithological column without interpretational loss because of their distant relationship to the rock types. There are about half a dozen, including bedding, unconformities, thin streaks, covered intervals, and finely interbedded (as opposed to intermixed) rocks which are closely related to either depositional history or the lithologies, and which it is essential to include in the main column. These will be referred to as miscellaneous symbols (Figure 1). The remainder, which are less related, often stand out more clearly on an adjacent column and will be referred to as accessory symbols (Figure 2). Some minerals present in minor amounts can be important stratigraphically yet need not be included in the main columnar log e.g. heavy residues. Others minerals can be generally represented on the main log and more specifically broken down by symbols outside it. Both can be regarded as accessory material. Fossil symbols can be treated in the same way, although even with non-detailed work it may be desirable to show them on the main log.

The foregoing suggests that a symbol system could be laid out as follows;

Main column
- Major symbols - basic symbols for main rock types.
- Minor symbols - basic symbols for secondary materials and common minerals.
- Miscellaneous symbols - for features intimately related to lithology or depositional history.

Accessory column
- Mineralogical symbols - for significant minerals present in minor amounts or for finer subdivision of main log rock types.
- Megatextural symbols - for all features of this type not intimately related to the sediments or their history.
- Fossil symbols - for identification of fossils.

SUGGESTED SYMBOL SYSTEM

Precedence is related to symbols in two ways. Organisations with experience of stratigraphic research can provide a guide to the practical worth of individual symbols. Precedence also requires that symbols which are generally accepted should be employed, wherever possible. This applies particularly to symbols used with the Bureau.

A great number of symbol systems have been employed at various times and it is only possible to consider a few. Excluding Bureau systems, the choice made here was governed by availability. Those considered are Shell Oil (System No. 1), Mobil Oil of Canada (No. 2), the Oklahoma Geological Survey (No. 3), and American

Stratigraphic Services Ltd. (No. 4). Professional Paper Publication #450-C, which contains symbolic logs and charts, has been used as a guide to United States Geological Survey symbols (No. 5). The symbols employed by the I.F.P. (No. 6) are also considered (Fehr, 1962). Finally, B.M.R. Circular No. 8 (No. 7), M.A. Condon (No. 8) and S. Nasr (No. 9) suggest Bureau preferences. For convenience, these systems are referred to below by number.

MAJOR SYMBOLS

Megagrade clastics. Granule grade material is allied with coarser clastics in Systems #1, 3 and 9, but is not considered in the others. In #3 and 9 irregular ovate symbols are used for granules, pebbles, cobbles and boulders, and the types are distinguished by varying symbol size. System No. 1 recommends this procedure as optional, and uses a similar symbol.

Breccias belong in this subclass of rocks. Separate symbols are given for these in Systems #1, 7, 8 and 9. #7 and 9 use triangles of various types; #1 uses irregular multi-sided closed symbols and #8 uses both. Even in outcrop it is not always practical to differentiate breccias and conglomerates, as shape of components is the essential distinguishing feature, and shape may be gradational. This suggests that symbols for all megagrade rocks should be related and capable of illustrating shape gradations. The Shell symbol for breccia and the more general ovate for rounded megagrade clastics seem adequate for this purpose (Figure 1).

There are difficulties to logging megagrade rocks from bit samples unless they are polygenetic, when the lithological range of cuttings indicates their presence. If monogenetic, they may be impossible to identify. If they are identified, they can be indicated symbolically by superimposing the appropriate megagrade symbol on that for the parent lithology.

System #4 attempts to show lithologies of the component fragments inside megagrade clastic symbols. Whether or not this is done should be a matter of individual taste, as should size variation of symbols to suggest clastic fragment size.

Sandstones. The universal symbol for sandstones consists of dots, and this symbol will apply to all sand grade rocks except sand grade carbonates and pyroclastic rocks. Where various types of sandstones are shown symbolically, the simple dot pattern will represent quartz sandstone.

Siltstones and Clay Rocks. Clay and claystone are generally differentiated from shale in symbol systems although composed of similar materials. By some definitions claystones are silty. By most, however, they are pale coloured, softish, often relatively thick bedded rocks while shales are generally indurated, thin bedded and darker. The two rock types are otherwise closely allied. Shales predominate, so may be used for comparison with siltstones.

There is more variation in the use of symbols for shale and siltstone than for any other common rock types. In different systems the same symbol is sometimes used for either.

System.	Siltstone (A)	Shale (B)
1	Double dots	Dashes (with other combination symbols)
2	Repeated dash/dot	Blank
3	Horizontal wiggles	Dashes
4	Double dots	Dashes of varying length
5	Repeated dash/3 dots	Dashes
6	Dashes	Unbroken lines
8	Dashes	Unbroken lines
9	Double dots	Double dashes.

Of these symbols Nos. 3A, 2B, and 9B can be considered undesirable on grounds of lack of conformity. # 3A can be better employed for clay rock. # 2B has limitations in showing rocks with an argillaceous component, e.g. argillaceous sandstone. # 9B has no major drawbacks but would put the Bureau at a disadvantage in dealing with logs originating in other organisations.

This reduces the selection of symbols for siltstones to dots, dashes, or both, and those for shale to horizontal lines of various length. In spite of their wide application symbols involving dots are not to be recommended for siltstones because:

(i) Silt is not a mixture of sand and clay particles, but is a distinct rock type composed of micrograde particles. The use of dots in any form leads, or can lead, to confusion with the sand symbol.

(ii) Silt grade rocks rarely have permeability, but are most important stratigraphically in that slight grade size changes can form either cap rock or reservoir rock. As borderline rocks, siltstones require clear symbolic definition.

(iii) It is impossible to show sand/silt mixtures symbolically if both dots and dashes, or dots alone, are used in the silt symbol. Mixed rocks of this type, like siltstones, can have stratigraphic significance.

(iv) Drafting is complicated if dots are used, because these have to be aligned to minimise confusion with the sand symbol.

On the basis of these points dashes are recommended as the silt symbol (Figure 1).

Horizontal lines of one kind or another are almost universally used for shale. The unbroken line used in Systems #6 and 8 has drawbacks in that it is the standard symbol for bedding. Where shales occur alone they are thin bedded, and there is no objection to an unbroken line. If rocks are only partly argillaceous however, it is impractical to use this symbol. Apart from giving a false impression of bedding, it is impossible to show proportions of argillaceousness. An apparent solution is to use a broken line for shale as well as siltstones, and to differentiate between the two by making the shale line appreciably longer. This is recommended here (Figure 1) and seems close enough to symbols already in use to be acceptable.

<u>Carbonates</u>. A brick pattern for limestones and a rhombic one for dolomites are accepted for carbonates, as these are employed on a worldwide basis. These symbols have limitations for detailed work, but can be used as a base to show almost any type of detail, including genetic and grade size relationships (see Use of Symbols).

<u>Evaporites</u>. Of the nine systems considered two (#2 and 3) do not distinguish between anhydrite and gypsum and four (# 1, 4, 8 and 9) do so. Two systems (# 6 and 7) do not give symbols for either.

Weathering and subsurface solution both tend to form gypsum at the expense of anhydrite, and in subsurface samples the two are commonly intimately mixed. In petroleum geology there is often little point in trying to separate the two rock types. This need not apply to other stratigraphic work, but it is suggested that one basic symbol will suffice for most purposes. If further detail is required an accessory symbol can be used to differentiate between the two deposits, or size or spacing variations can be made on the basic symbol.

System # 1 is the only one in which potassium and magnesium salts are differentiated symbolically. As these deposits are rare it is suggested that they can be shown by the symbol for halite for most work, and where necessary can be distinguished either by an accessory symbol or a variant of the halite symbol.

On the foregoing points only two basic symbols are needed for evaporites. The symbols used in the systems considered are as follows:

System.	Anhydrite & Gypsum	Halite
1	Vees	Inclined cross hatching
2	Inclined cross hatching	Cross hatching
3	Inclined parallel lines	Cross hatching
4	Inclined parallel lines	Cross hatching
5	Inclined parallel lines	?
8	Inclined or ordinary cross hatching	Squares
9	Vees	Squares.

The majority of symbols for halite consist of cross hatching. This symbol is more easily drafted than squares and is more adaptable to showing percentages and inclusions (Figures 2 and 3). For preference the symbol for anhydrite and gypsum should be related in design to that for halite, so inclined cross hatching is recommended. It is more mixible than the vee symbol, and leaves the inclined parallel line symbol free for other use.

Coal. The coal symbol is accepted on a world-wide basis as solid black infill. This is capable of showing beds or thin streaks but has virtually no miscibility. Special symbols of the type suggested in B.M.R. Circular # 8 will be necessary for representation of different kinds of coal. Isolated plant remains should be distinguished from coal (Figure 2).

MINOR SYMBOLS

Many minor symbols require careful consideration for miscibility because they will represent minerals in varying amounts or will be superimposed to represent replacement material. A number of minerals or materials could be considered either minor or accessory in status, depending on their relative abundance. Most of the commoner ones are considered as minor here.

Chert. Clastic chert is fairly common. Where it occurs in megagrade clastics it can be shown by employing a secondary chert symbol within the clastic one. Clastic chert of sand grade can be shown by a lithic symbol, discussed below, or more specifically by a variant of this symbol. Deposited chert is probably rare and most is composed of organic material like sponge spicules, radiolaria, or diatoms. It can be identified as such by appropriate fossil symbols. Apart from clastic chert therefore, the majority of cherts encountered in sediments are diagenetic or metasomatic in origin. They range from patchy silicification through well developed nodules to massive replacement chert. The chert symbol used in almost all symbol systems refers to this type. Those considered here employ;

System	Symbol
1	Triangles (silicification) and eyes(nodules)
2	Triangles
3	Triangles
4	Triangles of several types
5	Triangles of two types
7	Clusters of slant parallel dashes
9	Slant parallel lines.

Triangles are the most favoured symbol on a world-wide basis. Of the systems considered, it is only within the Bureau that slant lines have been used. This difficulty has to be resolved arbitrarily. It is recommended here that a slant parallel line symbol should be used because:

(i) This symbol has precedence within the Bureau.

(ii) The symbol has great miscibility. Percentage representation is easier and the host rock symbol stands out beneath the chert symbol.

(iii) The triangular symbol might be confused with the breccia symbol.

Clays and claystones. If a straight line is used to show shale it seems logical to suggest a wavy line of similar length for clay rocks. Shale/claystone mixtures can then be represented proportionally either by varying the amplitude of the wave or by intermixing straight or waved lines. In either case the advantages of the basic shale symbol would be preserved.

With specialised work it may be necessary to identify specific clays like bentonite and kaolin. This is easily done by varying the basic clay symbol. Symbols of this type are suggested on the accessory column. They also could be used on the main columnar log.

Diatomites, radiolarites, and sponge spicule deposits.

These deposits should be treated as organic rocks. Fossil symbols can be superimposed upon the lithological log to show them, using the principal of proportional representation. If the rock is completely organic only the fossil symbols need be used. Secondary silicification may be present with these rock types.

Feldspar. This mineral occasionally forms sedimentary rocks, and is important in some clastics. Symbols used for feldspar are rhombs (Systems # 1 and 8), upright crosses (# 2, 4, and 9), and oblongs (# 3). None was specifically suggested in B.M.R. Circular # 8.

An open symbol is always preferable to a closed one. Both for this reason and on a numerical basis the upright cross is suggested as the most suitable symbol for the Bureau.

It has igneous connotation which allows its use when there is uncertainty as to whether the feldspathic rock is clastic or is igneous material in place.

Glauconite. Greensand may be completely composed of glauconite, but the mineral is more typically disseminated in sandstones and carbonates. Symbols suggested for the mineral vary greatly. It is treated as an accessory in Systems #1 and 2, with letter references. A wave-like line is used in two others (# 3 and 4). System #8 and 9 use a symbol rather like that for conglomerate but with the background in solid black.

None of these symbols is very satisfactory. The conglomeratic one is immiscible. The wave-like symbol is close to the clay symbol suggested here. It seems appropriate to propose a new symbol for glauconite. The arrow-head one (Figure 1) is suitable, as it is open and can be represented proportionately. It is also standard on the Typemaster machine (see Use of Symbols).

Lithic Materials. None of the systems considered give a specific symbol for lithic constituents This sand grade material is usually composed of chert, clay and grains of unidentifiable material. A symbol is suggested which seems appropriate.

Igneous rocks. In sedimentary geology the initial classification of igneous rocks should probably be into pyroclastic and non-pyroclastic. In the latter type classification can be based upon either mode of emplacement and/or composition. Mode of emplacement can generally be observed or deduced from the stratigraphic log itself. On this basis composition is probably of greatest importance. For general work subdivision into acid, intermediate and basic should suffice.

Non-pyroclastic igneous rocks are mainly thick bedded or massive, so symbols for them can be highly individual. Pyroclastics, in contrast, are often interbedded and intermixed with sediments, so require miscible symbols.

Igneous rocks are not considered in two systems (#8 and 9). In the others there is a variety of both classificatory breakdowns and symbols. Systems #2 and 3 have the simplest systems. #2 uses one igneous (intrusive) and one volcanic (extrusive) symbol. #3 has a symbol for acid and a symbol for basic igneous rock. The symbols in all the systems consist of a variety of crosses, vees, irregular and paired dashes. B.M.R. Circular #8 gives latitude of choice. It is suggested that the most suitable general symbols for the non-pyroclastic igneous rocks (Figure 1) are:

Acid rocks - crosses on edge (#7 and #1)

Intermediate rocks - opened crosses on edge (#6)

Basic rocks - irregularly plotted vees (#2, 4, & 7)

Pyroclastic rocks range in grade from agglomerates to tuffs and in composition from acid to basic. Differentiation of the various types will be necessary in specific cases. The best way of doing this is probably to use a basic symbol for all pyroclastic rocks, and to vary it according to composition, grade size or texture. The most logical basic symbol is the igneous vee (Figure 1), oriented to indicate bedding. The symbol is open and miscible. More specific pyroclastic types can be indicated by adding dashes etc., to the vee or by varying the size of the symbol. Different types of tuff were differentiated in the first way by Fehr (System #6).

Metamorphic rocks. An inclined wavy line symbol, used in Systems #1 and 7, can be accepted for metamorphic rocks. The symbol, which is an abstraction of contorted bedding, has the advantage that the nature of the rock also can be indicated.

Micas. Various types of mica are a significant component of some greywackes and shales. Only System #3 gives a symbol for mica. This is a shallow vee, and is too similar to the pyroclastic symbol to be acceptable. Superimposed very short parallel dashes seems an appropriate symbol for micas, and is suggested here (Figure 2), to be used either as an accessory symbol or within the main log. An accessory letter symbol will suffice in some cases.

Phosphates. As well as forming economic deposits, phosphates can be significant in stratigraphic correlation work. Two symbols are used for the mineral in the systems considered. These are a double dot in #2 and 4, and an infilled "p" in #3. The double dots, or alternately an accessory letter symbol, is recommended. Phosphates tend to be disseminated or in nodular form rather than massive. The symbol is adaptable to all three cases (Figures 1 and 2).

Pyrites. This sulphide is widely present in shales, and although shown as an accessory may be worth representing on the main log. Only System #3 gives a specific symbol for the mineral. This is accepted.

Siderite and iron oxides. Both sedimentary iron carbonates and iron oxides can be of commercial interest, and can be significant in correlation work. It seems reasonable to use a symbol of similar design for both. A least a proportion of iron deposits are due to selective replacement and tend to be nodular or massive.

Of the systems considered only #4 gives symbols for siderite. These are slant lines for bedded deposits and solid dots for pellets. The latter symbol could lead to confusion. Pellets will either be clastic and can be shown by a clastic symbol, or will be secondary and can be shown by a concretion symbol. The parallel line symbol therefore, is accepted (Figure 1). It is miscible and can be superimposed on the symbols for host rocks where the deposits are secondary. Line spacing can be varied to differentiate between oxides and carbonates. For further differentiation, other spacing could be adopted or the lines could be broken.

Miscellaneous Symbols

The miscellaneous symbols shown on Figure 1 are fairly standard. The thin streak symbol is for very thin beds of significant lithology which cannot be shown at log scale without over emphasis. The general porosity symbol is of use in petroleum geology and hydrogeology, and is conventionally shown on the left-hand side of the main idium.

ACCESSORY SYMBOLS

As already noted, the definition of both mineralogic and fossil symbols as accessory or minor is somewhat arbitrary. In specific cases most could be used within the main columnar log. On Figure 2, where only letter symbols are given for mineralogic and fossil materials, it is intended that the symbol should be kept off the main log. Where abstract symbols are given their placing will depend mainly on the amount of detail desired on the main log. The symbols for depositional and structural features are relatively distantly related to lithology, so can be kept off the columnar log at all times.

The accessory symbols do not need to be specifically discussed. They will either be acceptable or unacceptable. A number at least will require alteration. Most originated with Systems #1, 8 and 9. None was suggested in B.M.R. Circular #8. Letter or abstract symbols already in use for surface maps are given without change.

USE OF SYMBOLS

It is in use that symbol systems prove themselves. Excluding the accessory symbols, most suggested here have been proven practical. Among other things, properly designed symbols should be adaptable to percentage representation of component mixtures. How this is done should be largely a matter of choice.

Figure 3 illustrates one way in which rocks consisting of mixtures of two components can be visually identified by symbols for seven percentage combinations. Proportional representation of three or more components is also possible with the symbols, and can be performed as systematically as desired. Figure 3 also shows how various rock types can be represented.

Some detailed logging methods can be considered briefly, to show that the symbols suggested here are adaptable to the methods.

i) Systems # 1, 2, 3, and 4, all use colour to emphasise lithological data. This has advantages and no obvious disadvantages, and colour can be superimposed on any black and white symbol system. There would be point to devising such a system for optional use within the Bureau, possibly relating interpreted depositional environment with lithological representation. Alternately, the present Bureau colour scheme for age indication could be employed on columnar logs.

ii) Organic deposits. The accessory fossil symbols can be introduced on the main columnar log to show carbonate rock genesis. This is done in System # 4, by introducing between one and three symbols to represent varying percentages of fossil material. The method tends to clutter the columnar log unless the carbonates are compositionally pure, and only unrecrystallised limestones are readily interpreted genetically. The method can be useful nevertheless.

iii) Grade relationships are important to intergranular porosity and permeability development in sediments, and any system which emphasises these relationships is of great use in petroleum geology. Clastic rocks and their symbols are based upon general grade size distinctions so the use of these symbols, plus others like the porosity symbol, and the accessory calcite or silica infill symbol, will provide some idea of grade size relationships and will tend to give satisfactory correlations. Carbonate interpretation is less satisfactory with standard symbols. A system of detailed symbols, based upon the basic ones, has been described (Drummond, 1963) and will be found effective in many cases both for showing detailed grade size relationships and improving carbonate correlations.

Sandstones cover a considerable grade range (1/16-2 mm.) and detailed grade relationships within them can only be shown by adopting more specific symbols. Fehr System (#6) employed dots of varying size for different grade classes of sandstones. A number of combinations of dots of varying size and arrangement is possible so this method, or one similar to it, can be recommended as an optional way of showing details of sandstone grade size in stratigraphic work.

The Bureau has ordered a Typemaster machine for log composition, and the symbols suggested here were restricted, wherever practicable, to those already on the machine. Of the major symbols only shale and the anhydrite/gypsum symbol are not present on the machine. Of the minor ones, claystone, pyroclastics, siderite, and iron ore symbols are absent. However, standard machine symbols can be adapted with very little change to most of these.

The Typemaster has limitations in showing mixed lithologies, so will be of most use for sections in which lithological descriptions are generalised to sandstone, shale, etc. Detailed sections will have to be completed by hand. No accessory symbols are available on the Typemaster. This makes the location of these on an accessory column, which can be filled in separately, all the more acceptable.

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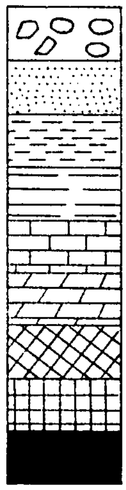
LITHOLOGIC SYMBOLS

MAJOR SYMBOLS



Megagrade clastics: breccia to conglomerate.

Sand rocks

Silt rocks

Shale

Limestone

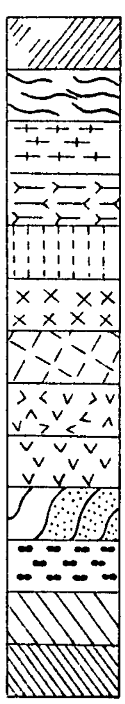
Dolomite

Gypsum and anhydrite

Halite

Coal

MINOR SYMBOLS



Secondary chert, patchy to massive.

Clays or claystone

Feldspar

Glauconite

Lithic materials of sand grade including chert, clay grains and unidentifiable material

Acid } *Igneous rocks*

Intermediate } *Igneous rocks*

Basic } *Igneous rocks*

Pyroclastic, in general } *Igneous rocks*

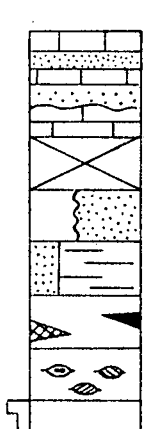
Metamorphics: general and quartzite.

Phosphate

Siderite

Iron oxides

MISCELLANEOUS SYMBOLS



Bedding (between sandstone and limestone)

Unconformity or disconformity (between sandstone and limestone)

No exposures or no samples

Partial exposure (sandstone)

Finely interbedded rocks (25% sandstone, 75% shale)

Thin streaks (anhydrite and coal)

Concretions (phosphate, chert and iron ore)

Porosity (good to poor)

ACCESSORY SYMBOLS

MINERALOGIC

An	Anhydrite
Ba	Barite
Bx	Bauxite
Be	Bentonite
Bit	Bitumen
C	Calcite crystals
	Calcite infill (partial and complete)
Do	Dolomite crystals
Gl	Glauconite
Au	Gold
Gp	Gypsum
Ck	Kaolin
L	Limonite
Mg	Magnesium salts
Mi	Micas
Ph	Phosphate, disseminated
K	Potassium salts
Py	Pyrites
	Salt inclusion
Sl	Selenite
	Silica infill (partial and complete)
S	Sulphur
SR	Sulphide residue (Asphaltite)

DEPOSITIONAL AND STRUCTURAL

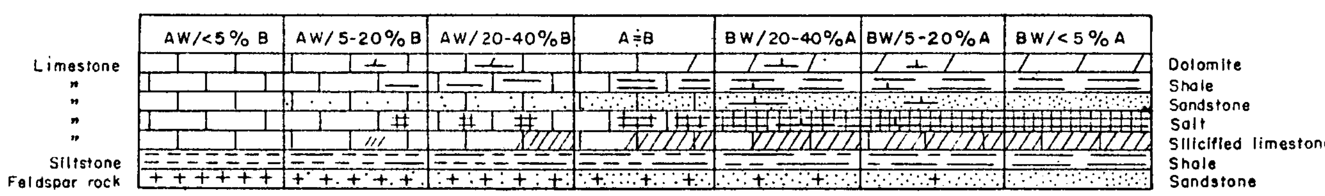
	Massive bedded
	Thick bedded
	Medium bedded
	Thin bedded
	Laminated
	Wave mark
	Current bedded
	Undulate bedding
	Fluting
	Cross bedding
	Graded bedding
	Scour and fill
	Burrow structure
	Convolute lamination
	Load cast
	Slump structure
	Trails
	Organically reworked
	Cone in cone stucture
	Salt cast
	Tectonically disturbed
	Highly disturbed
	Jointed
	Slickensides
	Stylolites
hd	Hard formation
hs	Hard streak
	Dip, where measured

FOSSIL AND GENETIC

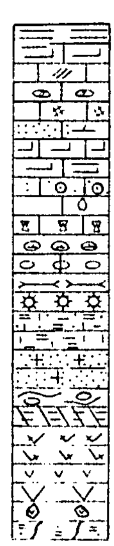
- Algae
- Ammonites
- Amphipora
- Belemnites
- Brachiopods
- Bryozoa
- Calcarenite
- Calcilutite
- Calcirudite
- Charophytes
- Conodonts
- Coprolites
- Corals
- Crinoids
- Diatoms
- Echinoids
- Fish remains, general
- Fish scales
- Foraminifera
- Fossils, general
- Gastropods
- Graptolites
- Klintite
- Oolites
- Ostracods
- Pelecypods
- Pisolites
- Plants, general
- Pseudo-oolites and bahamites
- Radiolaria
- Silicified wood
- Sponge spicules
- Sporomorphs
- Stromatoporoids
- Trilobites
- Vertebrates, general

EXAMPLES OF SYMBOL USE

1) % REPRESENTATION



2) VARIOUS ROCK TYPES



Shale, grading down to
limestone(calcilutite)
Limestone, slightly silicified
" , with abundant chert nodules
" , with abundant anhydrite inclusions
" , slight dolomitic, rather sandy
" , (calcilutite)
" , (calcilutite, slightly argillaceous)
" , (30-60% oolitic, sandy)
" , (5-30% crinoidal)
" , (pelecypod coquinite)
" , (conglomeratic)
" , (conglomeratic, alternative method)
Radiolarite
Diatomite
Greywacke, (quartz sand, lithic sand, silt, mica)
Greywacke, (lithic sand, silt, mica)
Arkose, (quartz sand, clastic feldspar)
Feldspathic sandstone
Tillite,(conglomerate in clay matrix)
Iron oxide replacing siltstone
Andesitic tuff
Rhyolitic tuff
Basaltic tuff
Basaltic agglomerate
Basaltic agglomerate (alternative method)
Gneiss, (mica, quartz)