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CLASSIFICATION OF THE SEDIMENTARY ROCKS

Compiled by

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INTRODUCTION

The method of classifying sedimentary rocks has been the subject of debate and disagreement right up until the present time. Consequently there are currently in use a number of related classifications which tend to complicate, rather than simplify, communication in this branch of geology.

Since there is a reasonable degree of agreement on the principles involved, it appears to be essential that one system should be agreed upon and used (with amendments if substantial improvement will result).

It is true that no system at present in use will satisfy all requirements. On the other hand, an established system at least results in a more satisfactory communication of ideas and is particularly useful if known internationally.

At present it is believed that the most widely used classification is that of Pettijohn, published in Sedimentary Rocks, Second Edition, 1957, Harper & Brothers.

Although fundamental research into the classification of sedimentary rocks is of considerable importance, it can be argued that excessive importance has been attached to this objective. It appears that research workers in this field have been strongly influenced by their own studies in restricted areas with a tendency to promote a classification suitable for a particular area.

The system of Pettijohn can generally be applied successfully to all types of sedimentary rocks in outcrop, well-cuttings and well cores.

Where detailed studies of particular types of sediment are undertaken, more comprehensive classifications may be necessary. For instance, where detailed descriptions of coals and carbonates are required, the following references are recommended.

BONE, W.A. and HIMUS, G.W., 1936 : "Coal - its constitution and uses. Longmans, Green and Co., London.

FOLK, R.L. 1959 : Practical petrographic classification of limestones. Am. Assoc. Petroleum Geologists Bull. Vol. 43.

An organization such as the Bureau of Mineral Resources makes use of three categories of rock names; a general name, used when the state of knowledge and the facilities available do not enable a more accurate diagnosis to be made; a specific name, determined after closer field study and possibly laboratory examination; and a detailed name, used only as a result of very detailed laboratory studies. This division into three categories is demonstrated by the following example, dealing with carbonate rocks:

General Name	:	Limestone or dolomite, with qualifying adjectives such as 'sandy'.
Specific Name	:	Calcirudite, calcarenite etc., with hybrid names sandy calcirudite, oolitic calcarenite etc.
Detailed Name	:	Intrasparite, biomicrite etc., after Folk (1959).

On the following pages the general principles of Pettijohn's system, with additions from Bone and Himus (1936) and Folk (1959) are recorded. For a more detailed explanation the publications by these authors should be consulted.

To separate the main rock groups, namely rudites - arenites - lutites - tuffaceous sediments - carbonates, it appears necessary to separate them by their relative volume in a rock. For practical purposes a 50% dividing line is the simplest method. Consequently a rock of which more than 50% is arenite will be termed a sandstone or greywacke, and a rock with more than 50% lutite will be termed a siltstone, mudstone or shale. The same concept applies to rudite, carbonates and tuffs.

CLASSIFICATION OF RUDITES

Pettijohn 1957, p243-282

General Names : Conglomerate, composed of rounded fragments (unconsolidated form: gravel); and breccia, composed of angular fragments (unconsolidated form: rubble).

The classification of rudites is based on the sizes of constituent fragments within the following ranges of diameter, (Pettijohn 1957, p.19).

Boulder Conglomerate	>	256mm.
Cobble "		64-256 mm.
Pebble "		2-64 mm.

The principal varieties of rudite are shown in the table below (Pettijohn p.255) and described briefly.

Rudite	Equivalent Arenite
1. Orthoquartzitic Conglomerate (Oligomict, oligomictic)	Orthoquartzite
2. Petromict Conglomerate (Polymict, polymictic)	Arkosic Sandstone / Lithic Sandstone
3. Tilloid	Greywacke
4. Tillite	
5. Intraformational conglomerates	-
6. Volcanic agglomerates and breccias	Tuffs and tuffogenous sediments

Oligomict Conglomerate : characterized by simple composition and consisting of resistant clasts such as quartzite, chert, jasper etc.; Typically less than an inch in size and well worn and rounded.

Polymict Conglomerates : commonly a mixture of plutonic, eruptive, sedimentary and metamorphic rocks. One type of pebble may predominate. Typically coarse but rapid changes common, poorly sorted. Rounding fair to good but associated arenites commonly subangular to angular. They usually form the thick, wedge-shaped, basin margin accumulations. May be basal or intercalated in the section.

Tilloid : conglomeratic mudstones with nonlaminated matrices. Range from a chaotic unassorted assemblage of coarse clasts set in a mudstone matrix to a mudstone with sparsely distributed cobbles. Crossbedding and other evidence of current bedding normally absent. Associated with greywackes, fine grained siltstone and lutites. Usually reasonably uniform in thickness, may occur in thin regular beds and may be repeated in the section. Origin attributed to subaqueous mudstreams such as turbidity currents.

Tillite : derived from glacial action and consists typically of an assortment of coarse clasts in a matrix of claystone or mudstone (rock flour) which may contain sporadic lenses and beds of angular arenite. The matrix may comprise the main mass of the deposit with the clasts varying from rare to common. Sorting and bedding poor but frequently associated with varved lutite representing seasonal deposition of mud material in lakes. The clasts in till and tillite may be parallel, tabular with a pentagonal outline, and may or may not exhibit glacial striations.

Intraformational Conglomerate : characterized by thinness, flat-pebble form, edgewise arrangement in some cases, restricted composition of the fragments (e.g. shale or limestone only). These deposits are formed by penecontemporaneous fragmentation and redeposition of the sediments. Due either to dessication and mudcracking during temporary withdrawal of the waters or subaqueous gliding and slumping. May also be associated with the flanks of limestone reefs.

Volcanic Conglomerate : for details see page 5.

CLASSIFICATION OF ARENITES

(Adapted from Pettijohn 1957, p. 283-339)

General names :

Sandstone : applied with feldspar $< 25\%$, matrix $< 15\%$, may be termed feldspathic sandstone if significant amount of feldspar is present ($\geq 10\%$).

Greywacke : applied when detrital matrix is estimated to be 15-50%, feldspathic greywacke if significant amount of feldspar is present ($\geq 10\%$).

Classification is based on the following grainsizes :

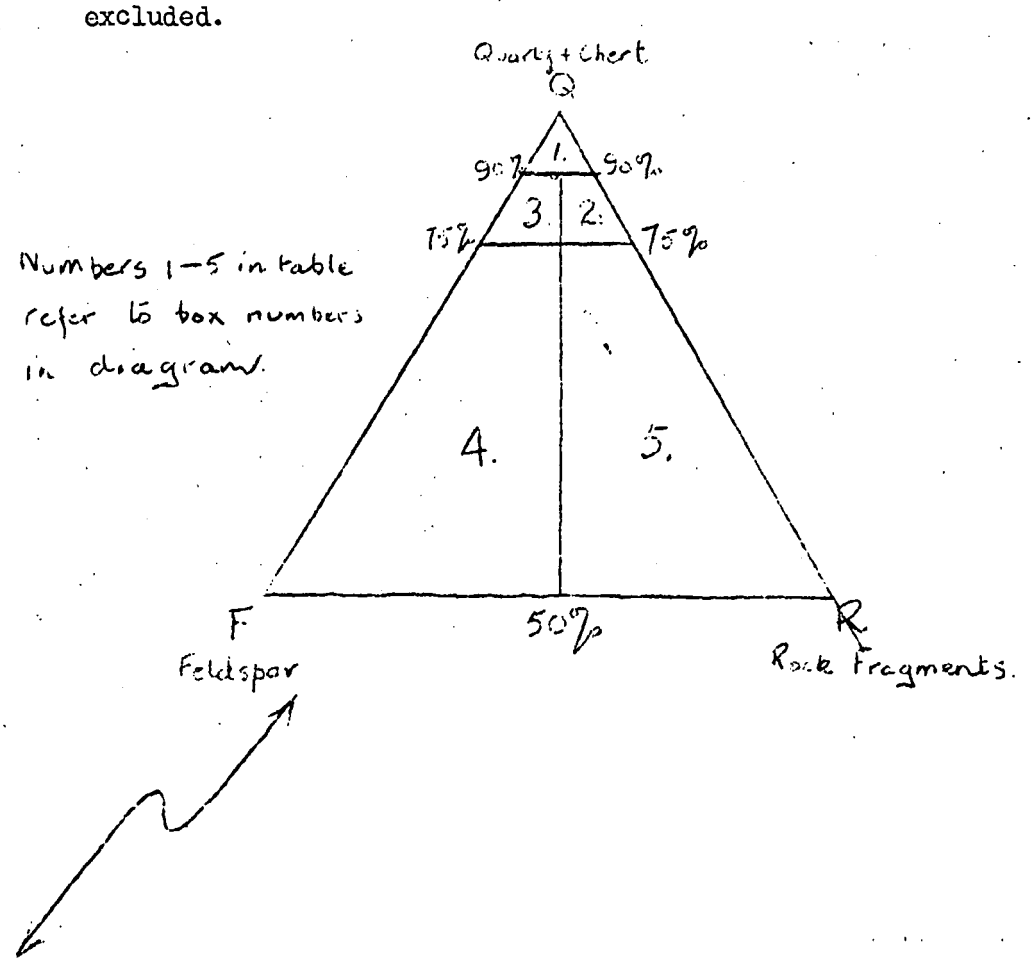
Very coarse	1-2mm.
coarse	$\frac{1}{2}$-1 (0.5-1.0)mm.
Medium	$\frac{1}{4}$-$\frac{1}{2}$ (0.25-0.5)mm.
Fine	$\frac{1}{8}$-$\frac{1}{4}$ (0.125-0.25)mm.
Very fine	1/16-$\frac{1}{8}$ (0.06-0.125)mm.

The diagram on the following page illustrates the bases of subdivision of arenites according to composition, in terms of the relative portions of quartz, feldspar and rock fragments.

Note: 1. The estimation of the relative % of Q, F and R is based on Q+F+R = 100%.

2. Matrix is restricted to lutite grainsize.

3. Secondary cement excluded.



Numbers 1–5 in table refer to box numbers in diagram.

QFR	GREYWACKE GROUP	SANDSTONE GROUP
	Detrital Matrix 15–50*%	Detrital Matrix <15%
1. Q > 90%	-	Orthoquartzite
2. Q 75–90% R + F 25–10% R > F	Lithic Greywacke	Protoquartzite (Lithic sandstone)
3. Q 75–90% F + R 25–10% F > R	(Rare type, name not available)	Subarkose (Arkosic sandstone)
4. Q < 75% R + F > 25% F > R	Feldspathic greywacke	Arkose (Arkosic sandstone)
5. Q < 75% R + F > 25% R > F	Lithic greywacke	Subgreywacke (Lithic sandstone)

* To avoid confusion the upper limit of the matrix is fixed at 50%. Rocks with matrix in excess of 50% are termed siltstone or mudstone with qualifying adjectives such as sandy if quartz grains exceed 10%. Pettijohn is not clear on this point and in his text indicates the matrix mass may be as high as 75%. (DJG)

CLASSIFICATION OF LUTITES

(Pettijohn 1957, p.340-380)

General Term : Siltstone : (unconsolidated form, silt)

Mudstone; claystone : (unconsolidated forms, mud, clay)

Grainsize Classification

Silt and siltstone	1/16-1/256 (0.06-0.004)mm.
Clay, claystone and mudstone	< 1/256 (.004)mm.

Silt and Siltstone : The terms should be restricted to rocks which contain over 50% silt size particles consisting typically of quartz grains, mica, feldspar, clay minerals and chlorite. Siltstones tend to be flaggy and may show small scale crossbedding and other current markings.

Clay and Claystone : The terms should be logically used for sediments consisting predominantly of clay minerals. However, the terms have been used loosely.

Mudstone : The term is loosely used but should be applied to a sediment, the composition of which is not precisely known, with grainsize less than 1/256 mm.

Silts, clays and muds usually contain a mixture of silt, clay and other fine material. The predominant type i.e. silt, clay or mud will determine the nomenclature.

Shale : Is commonly applied to laminated or fissile mudstone, claystone and siltstone. It may be used more satisfactorily as a qualifying term e.g. shaly mudstone.

VOLCANIC EJECTA

(Pettijohn 1957, p. 331-339)

Pyroclastic materials are classified according to size of component fragments :

Agglomerates and breccias	:	> 32mm. diameter
Lapilli tuff (cinders)	:	4-32mm.
tuff (ash)		$\frac{1}{4}$-4mm.
Fine tuff		< $\frac{1}{4}$ (.25)mm.

Agglomerates are defined as contemporaneous pyroclastic rock containing a predominance of rounded or subangular fragments more than 32mm. in diameter.

Volcanic breccias are composed of angular ejecta which may include both volcanic and country rocks. If matrix is abundant the term tuff breccia may be used.

Lapilli tuff consists of volcanic fragments, 4 to 32mm in diameter, in a tuff matrix.

The terms vitric, crystal, are applied where a tuff contains a significant amount of glass or crystal.

Hybrid rocks are termed tuffaceous greywacke, tuffaceous shale etc. or sandy tuff, clayey tuff etc. depending upon the relative amounts of tuffaceous material and normal clastic sediments.

LIMESTONE AND DOLOMITE

(Pettijohn 1957, p.381)

General Names : Limestone and dolomite, with hybrid terms such as sandy limestone.

Specific Names : calcirudite, calcarenite, calcilutite (sandy calcirudite, oolitic calcarenite etc.).

Detailed Names : after Folk (1959). Table 2.

The terms limestone and dolomite are restricted to rocks which contain more than 50% carbonate. Limestones are further restricted to rocks in which over 50% of the carbonate content is ~~calcium carbonate~~ and dolomites are restricted to those rocks in which over 50% of the carbonate is ~~magnesium carbonate~~ dolomite.

Hybrid rocks may be termed sandy, silty, muddy, sideritic, glauconitic, phosphatic etc. where the carbonate content is more than 50% and the sand, silt etc. is in excess of 10%.

The specific terms calcarenite, dolarenite etc. can be subdivided into the grainsize terms using the same system as for the non-carbonate rocks.

Table 1.

Specific names for carbonate rocks according to grainsize.

Grain Size		Rock Name
	> 64 mm.	very coarse calcirudite dolorudite
16	- 64 mm.	coarse calcirudite dolorudite
4	- 16 mm.	medium calcirudite dolorudite
2	- 4 mm.	fine calcirudite dolorudite
0.5	- 2 mm.	coarse calcarenite dolarenite
0.25	- 0.5 mm.	medium calcarenite dolarenite
0.125	- 0.25 mm.	fine calcarenite dolarenite
0.062	- 0.125 mm.	very fine calcarenite dolarenite.
0.031	- 0.062 mm.	coarse calcilutite dololutite
0.016	- 0.031 mm.	medium calcilutite dololutite
0.008	- 0.016 mm.	fine calcilutite dololutite
0.004	- 0.008 mm.	very fine calcilutite dololutite

Table 2

TABLE I. CLASSIFICATION OF CARBONATE ROCKS

Volumetric Allochem Composition				Limestones, Partly Dolomitized Limestones, and Primary Dolomites (see Notes 1 to 6)					Replacement Dolomites[7] (V)	
				>10% Allochems Allochemical Rocks (I and II)		<10% Allochems Microcrystalline Rocks (III)				
				Sparry Calcite Cement > Microcrystalline Ooze Matrix	Microcrystalline Ooze Matrix > Sparry Calcite Cement	1–10% Allochems	<1% Allochems	Undisturbed Bioherm Rocks (IV)	Allochem Ghosts	No Allochem Ghosts
				Sparry Allochemical Rocks (I)	Microcrystalline Alochemical Rocks (II)					
>25% Intraclasts (i)				Intrasparrudite (Ii:Lr) Intrasparite (Ii:La)	Intramicrudite* (IIi:Lr) Intramicrite* (IIi:La)	Most Abundant Allochem: Intraclasts: Intraclast-bearing Micrite* (IIIi:Lr or La)	Micrite (IIIm:L); if disturbed, Dismicrite (IIImX:L); if primary dolomite, Dolomicrite (IIIm:D)	Biolithite (IV:L)	Evident Allochem: Finely Crystalline Intraclastic Dolomite (Vi:D3) etc.	Medium Crystalline Dolomite (V:D4)
<25% Intraclasts	>25% Oölites (o)			Oösparrudite (Io:Lr) Oösparite (Io:La)	Oömicrudite* (IIo:Lr) Oömicrite* (IIo:La)	Oölites: Oölite-bearing Micrite* (IIIo:Lr or La)			Coarsely Crystalline Oölitic Dolomite (Vo:D5) etc.	Finely Crystalline Dolomite (V:D3)
	<25% Oölites	Volume Ratio of Fossils to Pellets: >3:1 (b)		Biosparrudite (Ib:Lr) Biosparite (Ib:La)	Biomicrudite (IIb:Lr) Biomicrite (IIb:La)	Fossils: Fossiliferous Micrite (IIIb: Lr, La, or Ll)			Aphanocrystalline Biogenic Dolomite (Vb:Dl) etc.	
		3:1–1:3 (bp)		Biopelsparite (Ibp:La)	Biopelmicrite (IIbp:La)	Pellets: Pelletiferous Micrite (IIIp:La)			Very Finely Crystalline Pellet Dolomite (Vp:D2) etc.	etc.
		<1:3 (p)		Pelsparite (Ip:La)	Pelmicrite (IIp:La)					

NOTES TO TABLE I

*Designates rare rock types.

[1] Names and symbols in the body of the table refer to limestones. If the rock contains more than 10 per cent replacement dolomite, prefix the term "dolomitized" to the rock name, and use DLr or DLa for the symbol (e.g., dolomitized intrasparite, Ii:DLa). If the rock contains more than 10 per cent dolomite of uncertain origin, prefix the term "dolomitic" to the rock name, and use dLr or dLa for the symbol (e.g., dolomitic pelsparite, Ip:dLa). If the rock consists of primary (directly deposited) dolomite, prefix the term "primary dolomite" to the rock name, and use Dr or Da for the symbol (e.g., primary dolomite intramicrite, IIi:Da). Instead of "primary dolomite micrite" (IIIm:D) the term "dolomicrite" may be used.

[2] Upper name in each box refers to calcirudites (median allochem size larger than 1.0 mm.); and lower name refers to all rocks with median allochem size smaller than 1.0 mm. Grain size and quantity of ooze matrix, cements or terrigenous grains are ignored.

[3] If the rock contains more than 10 per cent terrigenous material, prefix "sandy," "silty," or "clayey" to the rock name, and "Ts," "Tz," or "Tc" to the symbol depending on which is dominant (e.g., sandy biosparite, TsIb:La, or silty dolomitized pelmicrite, TzIIp:DLa). Glauconite, collophane, chert, pyrite, or other modifiers may also be prefixed.

[4] If the rock contains other allochems in significant quantities that are not mentioned in the main rock name, these should be prefixed as qualifiers preceding the main rock name (e.g., fossiliferous intrasparite, oölitic pelmicrite, pelletiferous oösparite, or intraclastic biomicrudite). This can be shown symbolically as Ii(b), Io(p), IIb(i), respectively.

[5] If the fossils are of rather uniform type or one type is dominant, this fact should be shown in the rock name (e.g., pelecypod biosparrudite, crinoid biomicrite).

[6] If the rock was originally microcrystalline and can be shown to have recrystallized to microspar (5–15 micron, clear calcite) the terms "microsparite," "biomicrosparite," etc. can be used instead of "micrite" or "biomicrite."

[7] Specify crystal size as shown in the examples.

A detailed classification has been developed by Folk (A.A.P.G. Vol. 43, 1959) which is primarily designed for more detailed petrographic studies. The classification is illustrated on the accompanying table 2 after, Folk (1959).

Miscellaneous Carbonate Rocks

Coquina - (Coquinite) detrital limestones consisting wholly, or nearly so, of sorted fossil debris which is more or less cemented.

Coquinoid - a deposit consisting of coarse shelly material which has accumulated in place and generally has a fine-grained matrix. (For the finer shelly deposits of calcarenite grade the term microcoquina may be used).

Encrinitic - crinoid coquina which commonly is relatively fine-grained.

Lithographic limestone - very fine-grained, dense, homogeneous calcilutite with conchoidal or subconchoidal fracture.

Tufa - spongy, porous, chemical limestone which forms a thin surficial deposit about springs, seeps and exceptionally in rivers. Commonly contains imprints of leaves and stems of plants. It can also be siliceous.

Travertine - dense banded chemical limestone common in limestone caverns and includes stalactites and stalagmites.

Caliche - a lime rich deposit formed in the soil profile of semi-arid to arid regions. Old caliches are indurated and may be characterized by large, concentrically banded masses. The term also has other meanings (see A.G.I. Glossary).

Bioherm - a dome-like mound-like, lens-like or otherwise circumscribed mass; built exclusively or mainly by sedentary organisms and enclosed in a rock of different lithologic character. Bioherms vary in size and shape and may be composed in part or entirely of algal, stromatoporoid and coral colonies, crinoid remains, brachiopod remains etc.

Limestone reef - large bioherms or a number of associated biohermal masses with associated flank sediments and inter-reef sediments, which have been subjected to wave action during growth, will form what is commonly known as a reef.

Biostrome - (biostromal limestone) - deposits which have been formed under similar conditions to bioherms by sedentary organisms and which are stratified. The limestone varies from those with abundant fossil remains (coquinoid) to those with few fossil structures preserved (e.g. algal origin).

Chalk - carbonate deposits formed mainly by the accumulation of the tests of planktonic calcareous micro-organisms, chiefly Foraminifera. Chalk is typically a porous, fine textured, friable material consisting almost entirely of calcium carbonate as calcite. Under surface weathering lithification may occur.

HYBRID ROCKS

In practice it is common to find rocks consisting of mixtures of the main groups. For the purposes of this classification the minor constituents must exceed 10% before they are taken into account in the name of the sediment. The presence of less than 10% would be referred to in the description of the rock type.

To avoid confusion in the case of carbonate and non-carbonate mixtures, the following is suggested :

Calcarenaceous (dolarenaceous) orthoquartzite when an orthoquartzite contains over 10% calcarenite (dolarenite) grains compared with a calcareous (dolomitic) orthoquartzite which contains a calcareous or dolomitic cement.

Similar naming is applicable to other hybrid rocks, some examples of which are listed below :

Silty mudstone
Muddy siltstone
Conglomeratic arkose, greywacke
Sandy conglomerate
Phosphatic sub-greywacke

MISCELLANEOUS SEDIMENTARY ROCKS

Peat - Brown to black, unconsolidated, moist, combustible (when air-dried), non-crystalline material formed by the partial decomposition of swamp vegetation. It is very porous and has high moisture content, 50-90%. The fibrous material, dried to a moisture content of 10-20%, has high volatile content, low fixed carbon and ash and low heat value. (Coal Nomenclature from Bone, W.A. & Himus, G.W., 1936. Longmans Green & Co. London).

Brown Coal - Nearly opaque, brown, dark brown or black with dull earthy or resinous lustre. Its moisture content ranges from 10-70%. It is low in fixed carbon (10-45%), heat value ($\leq$ 9500 BTU/lb. moist), ash ($\leq$ 5%), volatile (20-53%). It is a "weathering" and "non-agglomerating" coal intermediate in rank between peat and sub-bituminous coal.

Sub-bituminous Coal - Intermediate in rank between brown coal and bituminous coal. It is black, dull to moderately bright in lustre, usually laminated. It is "weathering" and "non-agglomerating". (See A.G.I. Glossary for "weathering" and "agglomerating" as applied to coals). Burns with a long flame. Moisture content 10-30%, volatiles 30-50%, fixed carbon 35-50%, heat value 9000-11000 BTU/lb.

Bituminous Coal - Soft coal black or dark grey, more or less laminated coal with a resinous, pitchy or earthy lustre. "Non-weathering" and "agglomerating". Moisture 2-10%, ash 2-12%, volatiles 20-40%, fixed carbon 50-75%, heat value 11000-14500 BTU/lb moist. Burns readily with long smoky flame.

Semi-bituminous Coal - Coal intermediate in rank between bituminous coal and anthracite. It is black, laminated or massive, pitchy or dull in lustre, sub-conchoidal in fracture, and burns well in a good draught with a short smokeless flame. It is "non-weathering" and "non-agglomerating". Moisture content $\leq$ 5%, ash 5-8%, volatile content 12-25%, fixed carbon 70-80%, heat value 13,500 - 14,500 BTU/lb. Used as a steam coal.

Anthracite - Hard, black, lustrous, opaque coal. Has a smooth fracture and is heaviest of the coals (S.G. 1.5-1.8). Ignites with difficulty but burns in a good draught with an intense heat. Moisture $\leq$ 8%, fixed carbon 84-90%, heat value 13,550 - 14,500 BTU/lb. "Non-weathering" and "non-agglomerating".

Cannel Coal - Dull to satiny or greasy, black, brown or grey, massive or thin-bedded coal with conchoidal fracture. Consists of finely disintegrated vegetable debris, with fragments of cuticles, spore spicules, and resin bodies.

Boghead Coal - Dull to satiny, black and brown, massive or thin-bedded with conchoidal fracture. The distinctive feature of bog-head coals is the presence of translucent yellow, algal colonies. The body of the coal consists of comminuted vegetable debris, fragments of cuticles, spore exines and resin.

Oil Shale - Impure sapropelic deposits which on distillation yield oils consisting principally of paraffins and olefines.

Torbanite - Kerosene shale. Brownish black to greenish black sapropelic material, intermediate between rich oil shale and boghead coal. Streak yellow-brown to grey, conchoidal to hackly fracture, S.G. 1.008 - 1.3, lustre dull to satin. Algal colonies up to 0.1 mm. in diameter. Moisture $<$1%, fixed carbon 5-30%, volatile 45-90%, ash up to 50%. Destructive distillation yields 70-120 gallons of hydrocarbon distillate per ton.

Petroleum and Natural Gas - Broad terms for mixtures of various hydrocarbons found in nature.

Solid forms have been named:

Asphalt - a solid form of bitumen

Albertite - a solid bitumen, black, jet-like lustre, conchoidal fracture (related solid hydrocarbons have been termed gilsonite and grahamite).

Elaterite - soft elastic substance consisting of hydrocarbons.

Ozokerite - Green to brown wax consisting of higher members of paraffin series. Often occurs as vein-like deposits.

Chert, Flint, Jasper, Jaspilite - (Pettijohn 1957, p.432)

Terms used for dense cryptocrystalline material composed of chalcedony and cryptocrystalline quartz. The rock has a tough splintery to conchoidal fracture and can occur in almost any colour. May originate from silicification of rocks, such as limestone, diatomite, or originate from direct precipitation of silica.
Jaspilite is reserved for rocks in which thin jasper layers alternate with beds of hematite.

Porcellanite - (Pettijohn 1957, p.433) - Used chiefly with reference to impure cherts. Commonly the included material is argillaceous or calcareous.

Loess - (Hatch Rastall & Black 1938) - Fine-grained aeolian deposit of purely detrital origin. The particles consist of sharply angular chips of minerals such as quartz, feldspar, calcite and mica. Clay minerals are absent or in minor amounts. Typically unstratified and very uniform in texture. Usually associated with the re-distribution of glacial debris.

Laterite - A massive vesicular, pisolitic, or concretionary ironstone formation nearly always associated with peneplains and resulting from prolonged subaerial leaching of rock and the oxidation of the weathered products. The composition ranges from ferruginous to aluminious and rarely manganiferous. The term laterite is normally applied to the upper, so-called ferruginous zone of the laterite profile, which overlies the mottled and pallid zones.

Greensand - (Pettijohn 1957, p.467) - Applied to unconsolidated glauconite rich sands. Sands composed mainly of glauconite are dark to light green (weathering to brown). Mixed sands have a salt and pepper appearance. Grainsize divisions applied as for arenites.

Diatomite - (Diatomaceous Earth), Radiolarite Pettijohn 1957, p.433. Terms applied to white, cream, rarely buff, red or brown homogeneous, porous, friable rocks composed of the opaline tests of diatoms or radiolaria respectively.

Cherty iron carbonate - (Pettijohn 1957, p.452). Typically consists of rhythmically interbedded, fine grained, thin layers of siderite and chert.

Clay Ironstone - (Pettijohn 1957, p.453). Applied when the iron carbonate contains argillaceous material.

Bedded iron oxides - (Pettijohn 1957, p.453.). Primary or pene-contemporaneous replacement. Layered iron-rich sediments, commonly oolitic and fossiliferous, consisting chiefly of hematite, chamosite, siderite and may contain phosphate, calcite and quartz.

Phosphorite - (Pettijohn 1957, p.470-478). A deposit composed mainly of phosphate minerals. The rock should be termed a phosphorite when the phosphate is the major constituent. (Usually nodular or pelletal and interbedded with carbonate or other clastic sediments).

Evaporites - (Pettijohn 1957, p.478-486). Rock salt (halite), gypsum, anhydrite.