Winrock Wizard

User Guide — Classifying Rock Types Using the IUGS Scheme

Modal classification after Streckeisen / IUGS

Applies to: **WinrockWizard.html** (HTML edition)

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Contents

1. About This Guide

1.1 Who it is for

This guide is written for geologists, petrographers, students and exploration staff who need to put a defensible name on a rock from its *mode* — the measured or estimated volume percentages of the minerals it contains. It assumes you can identify common rock-forming minerals in hand specimen or thin section, but it does not assume you have memorised the IUGS field boundaries. Everything the wizard needs, and everything it will give back, is documented here.

The guide covers the HTML edition of Winrock Wizard (`WinrockWizard.html`), which runs in any modern browser with no installation, no plug-ins and no internet connection. Simply double-click the file, or drag it into a browser window.

1.2 What the wizard does and does not do

It does:

- Normalise the three end-member percentages you enter so they total 100 %, exactly as you would do by hand before plotting on a ternary diagram.
- Locate the normalised composition within the appropriate IUGS/Streckeisen field and return the recommended root name.
- Apply the secondary discriminants — plagioclase An content, mafic mineral content `M`, and olivine as a proportion of the mafics — where the IUGS scheme requires them.
- Walk you through a series of yes/no or multiple-choice questions for rock groups that are not classified on a ternary diagram (metamorphic, duricrust, meteorites, pyroclastics, lamprophyres and most sedimentary rocks).
- Report the normalised values it actually used, so your result is reproducible and auditable.

It does not:

- Identify minerals for you. Garbage in, garbage out — the quality of the name depends entirely on the quality of the mode.
- Perform a CIPW norm or any other chemical recalculation. The only chemical diagram in the wizard is the carbonatite triangle, and that expects oxide weight percentages you supply directly.
- Apply the TAS (total alkali–silica) chemical classification for fine-grained volcanic rocks. If your rock is too fine grained to obtain a reliable mode, TAS is the correct tool and the wizard cannot substitute for it.
- Store, print or export results. Record the rock name and the normalised values yourself before moving to the next sample.

> **A note on authority.** The field boundaries built into the wizard follow the recommendations of the IUGS Subcommission on the Systematics of Igneous Rocks, as published by Streckeisen (1976, 1979) and consolidated in Le Maitre (2002). Where the wizard's implementation differs from the published scheme — and there are a handful of places where it does — those differences are flagged in §12.2 so that you can decide for yourself.

2. Quick Start

2.1 Five-step workflow

1. **Open the file.** Double-click `WinrockWizard.html`. The wizard opens on the Igneous Rock Group with the Plutonic QAPF diagram pre-selected.
2. **Pick your rock group.** Use the first drop-down in *Step 1 — Rock Group*: Igneous, Sedimentary, Metamorphic, Duricrust or Meteorites.
3. **Pick your classification diagram.** For Igneous and Sedimentary rocks a second drop-down appears, grouped under headings such as *QAPF (Quartz-bearing)*, *Gabbroic* or *Sandstones & Wackes*. Metamorphic, Duricrust and Meteorite rocks skip straight to question mode.
4. **Enter your data.** Type the three end-member percentages into *Step 2*. The field labels change to match the diagram you chose. Fill in any of the *Optional — Additional Data* boxes that are visible; each one that appears is relevant to the chosen diagram.
5. **Click *Classify Rock*.** The result panel appears below the button, giving the diagram used, the rock name in large type, and the normalised end-member values.

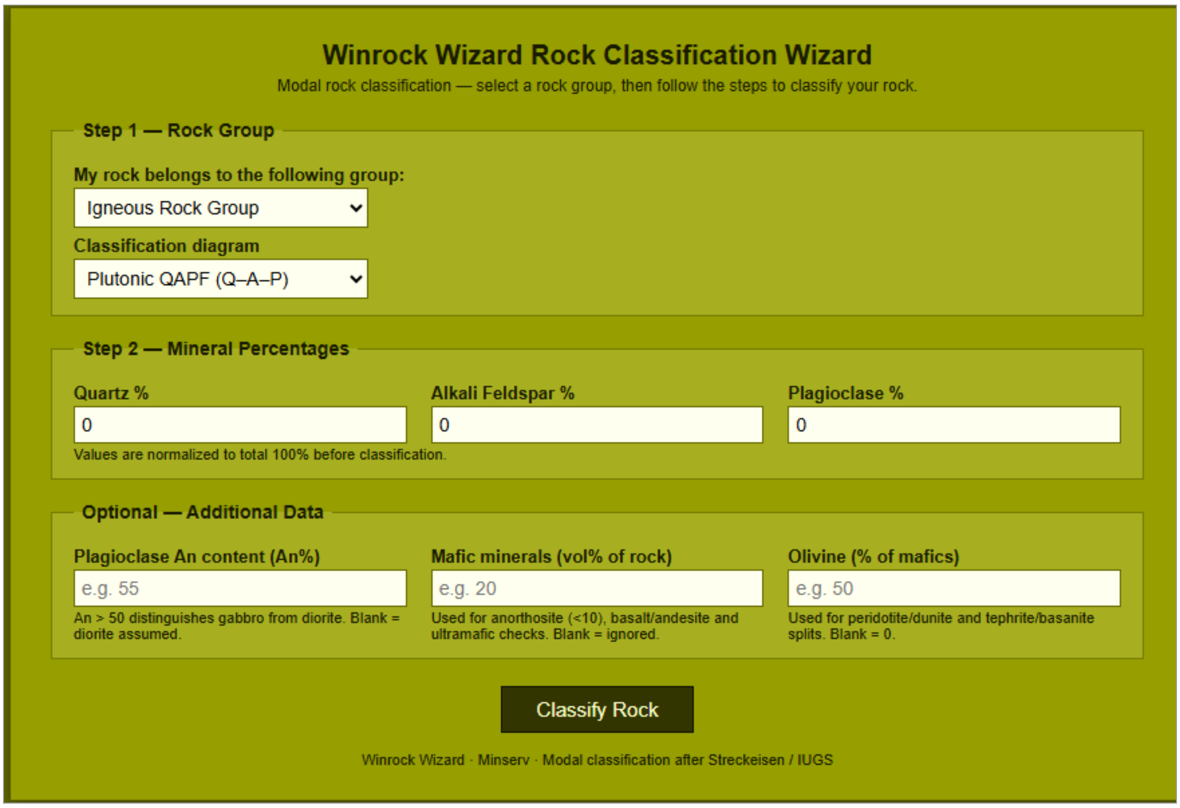

Figure 1 — The opening screen. Igneous Rock Group and Plutonic QAPF are selected by default; all three optional data boxes are shown because they all apply to that diagram.

2.2 Your first classification

Try a coarse-grained, light-coloured plutonic rock in which you have point counted 30 % quartz, 31 % alkali feldspar and 22 % plagioclase, the remaining 17 % being biotite and hornblende.

1. Leave Step 1 on **Igneous Rock Group** and **Plutonic QAPF (Q–A–P)**.
2. Enter `30`, `31` and `22` into the Quartz, Alkali Feldspar and Plagioclase boxes. Do *not* enter the mafics — they are excluded from the QAPF sum by definition.
3. Leave the optional boxes blank.

4. Click **Classify Rock**.

The wizard reports **Monzogranite**, and beneath it `Normalized: Quartz 36.1 % · Alkali Feldspar 37.3 % · Plagioclase 26.5 %`. Those normalised numbers are what was actually plotted: 30 / 83 = 36.1 %, and so on. Quoting them alongside the name in your log makes the determination reproducible.

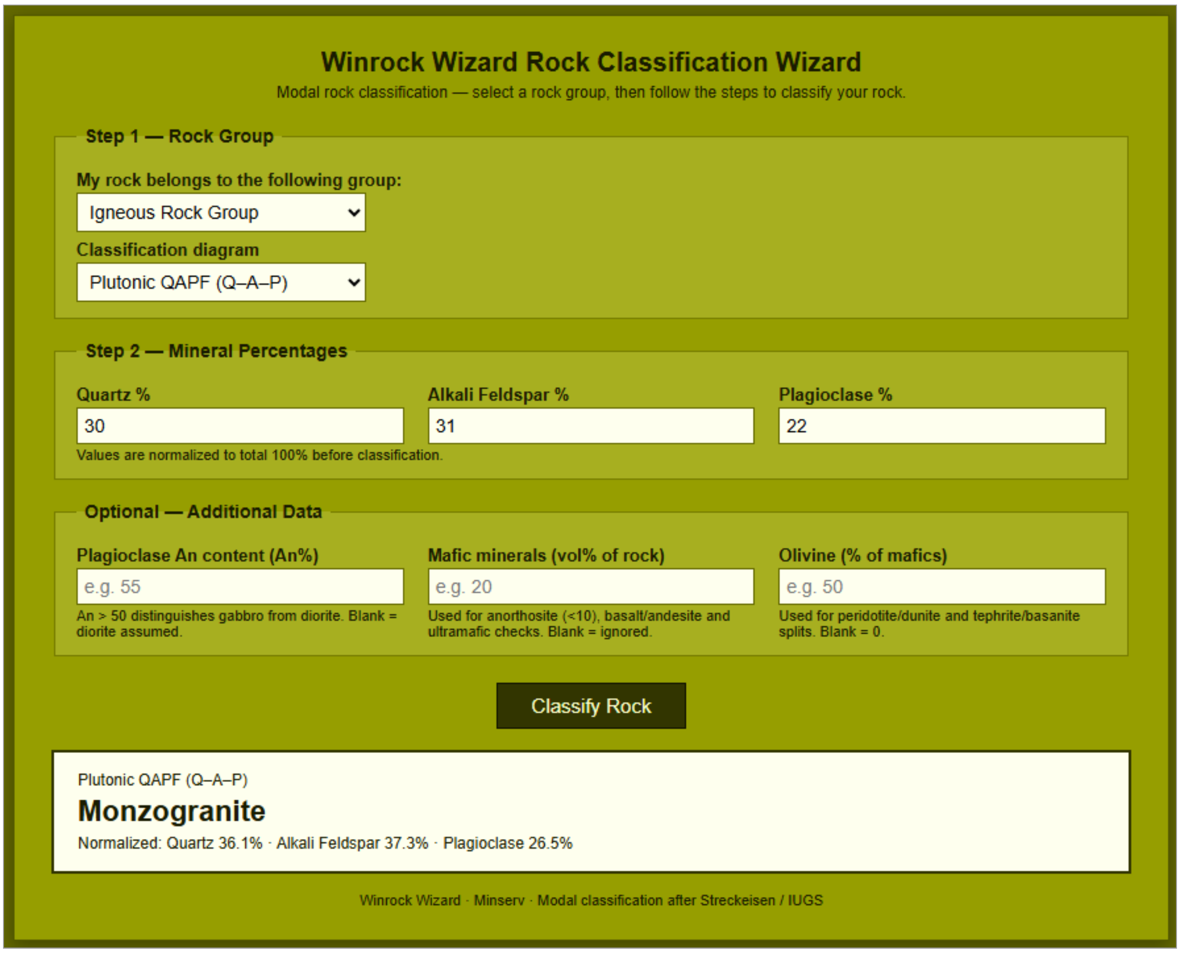

Figure 2 — A completed classification. The result panel gives the diagram, the name, and the normalised composition actually used.

3. The IUGS Scheme in Brief

3.1 Modal versus chemical classification

The IUGS scheme classifies igneous rocks on their *mode* wherever the mode can be measured. The mode is the set of volume proportions of the minerals actually present, normally obtained by point counting a stained slab or a thin section. This is a deliberate choice: a rock name should describe what the rock is made of, not what a calculation says it might have crystallised into.

Chemical classification (the TAS diagram, the CIPW norm) is a fall-back, reserved for rocks that are too fine grained, too glassy or too altered for a reliable mode. Winrock Wizard is a modal classifier throughout, with the single exception of the carbonatite triangle, which the IUGS scheme itself defines chemically.

3.2 The QAPF double triangle

The backbone of igneous classification is the QAPF double triangle, four apices arranged as two triangles sharing the A–P base:

- **Q** — quartz and other SiO_2 polymorphs (tridymite, cristobalite).
- **A** — alkali feldspar: orthoclase, microcline, sanidine, anorthoclase, perthite, and albite up to An_5.
- **P** — plagioclase from An_5 to An_{100}, plus scapolite.
- **F** — feldspathoids ("foids"): nepheline, leucite, sodalite, nosean, haüyne, cancrinite, analcime, and the pseudo-leucites.

Quartz and foids are mutually exclusive in a rock at equilibrium, so a given specimen plots in either the upper (Q–A–P) triangle or the lower (F–A–P) triangle, never both. This is why the wizard offers them as separate diagrams: *QAPF (Quartz-bearing)* and *QAPF (Foid-bearing, FAP)*.

```
       Q (100)                          F (100)
         /\                               \/
        /  \      quartz-bearing           \  foid-bearing
       /    \     rocks plot here           \  rocks plot here
      /______\                               \/
     A        P                             A —— P
  P' = 100 × P / (A + P) — measured left to right along the A–P join
```

Within each triangle the position of a point is fixed by two numbers, and these are precisely the two numbers the wizard computes for you:

- **Q** (or **F**), the normalised percentage of the apex mineral — this places the point vertically, in one of the horizontal bands of the diagram.
- **P′**, the plagioclase ratio `100 × P / (A + P)` — this places the point horizontally, in one of the vertical strips.

Everywhere in this guide, the horizontal position of a QAPF field is given as a range of P′, not of raw P. The standard vertical divisions fall at P′ = 10, 35, 65 and 90; the standard horizontal divisions at Q = 5, 20 and 60 (plutonic) or F = 10, 60 and 90.

3.3 Normalisation to 100 %

Only the felsic framework minerals go into the QAPF sum. Micas, amphiboles, pyroxenes, olivine, oxides, carbonates and accessory phases are all excluded, then the three remaining values are recalculated so that they total 100 %. The wizard does this automatically:

$$Q' = 100 \times Q / (Q + A + P) \qquad A' = 100 \times A / (Q + A + P) \qquad P'' = 100 \times P / (Q + A + P)$$

Because of this you may enter your numbers in any consistent units — raw point counts, percentages of the whole rock, or percentages already recalculated to 100 %. Entering 30 / 31 / 22 and entering 36.1 / 37.3 / 26.5 give exactly the same answer. The one thing you must not do is include the mafic minerals in the three boxes; that would displace the point toward the origin of the diagram and can change the name.

> **Common error.** Entering the whole-rock modal percentages including mafics — for example 30 quartz, 31 alkali feldspar, 22 plagioclase and then putting the remaining 17 % of biotite into one of the three boxes. Mafics belong in the optional *Mafic minerals* box, never in Step 2.

3.4 The colour index M

The colour index `M` is the total volume percentage of mafic and related minerals in the whole rock — olivine, pyroxenes, amphiboles, micas, opaques, and the accessories. It is the complement of the felsic fraction, and it is the quantity you type into the *Mafic minerals (vol % of rock)* box.

M matters in four places in the wizard:

- **M < 10** in the plagioclase corner of the plutonic QAPF triangle changes *Gabbro* or *Diorite* to **Anorthosite**.
- **M ≥ 90** in the same corner takes the rock out of QAPF altogether and into the ultramafic field, where the olivine proportion then decides between peridotite, dunite and pyroxenite.
- In the **volcanic** QAPF triangle, M distinguishes *Andesite* (M ≤ 35) from *Basalt* (M > 35).
- In the **charnockite** diagram, M < 10 in the plagioclase corner gives **Anorthosite** in place of Norite.

If you leave the box blank, the wizard simply skips these tests. That is safe but it means an anorthosite will be reported as a diorite or gabbro, so fill the box in whenever the rock is conspicuously leucocratic or melanocratic.

3.5 When QAPF does not apply

Rocks with M ≥ 90 are ultramafic and are classified on their own diagrams (Ol–Opx–Cpx or Ol–Px–Hbl). Gabbroic rocks — those in the plagioclase corner with M between 10 and 90 — have their own subdivision on the Plag–Px–Ol and Plag–Px–Hbl triangles, which resolve norite from gabbro from troctolite in a way the QAPF triangle cannot. Carbonatites, melilite-bearing rocks, charnockites, lamprophyres and pyroclastic rocks each have a dedicated scheme. The wizard exposes all of them under *Other Igneous* in the diagram drop-down.

4. The Wizard Interface

4.1 Step 1 — Rock Group

The first drop-down, labelled *My rock belongs to the following group*, holds the five top-level groups. What happens next depends on which you choose:

Rock group	What appears next	Notes
Igneous Rock Group	Classification-diagram drop-down, then either Step 2 boxes or questions	Eleven ternary diagrams plus two question trees (pyroclastics, lamprophyres)
Sedimentary Rock Group	Classification-diagram drop-down, then either Step 2 boxes or questions	Two ternary diagrams plus seven question trees
Metamorphic Rock Group	Questions immediately	No ternary diagrams; no diagram drop-down is shown
Duricrust Rock Group	Questions immediately	Iron oxide, silica, colluvium or carbonate
Meteorites Rock Group	Questions immediately	Single question, five outcomes

For Igneous and Sedimentary rocks a second drop-down, *Classification diagram*, appears immediately below. Its entries are organised under sub-headings so that related diagrams sit together — for example *Gabbroic* contains both the Plag–Px–Ol and the Plag–Px–Hbl triangles. Changing this drop-down instantly relabels the Step 2 input boxes and shows or hides the optional boxes; it also clears any previous result.

4.2 Step 2 — Mineral Percentages

Three numeric boxes. Their labels are not fixed — they change to match the end members of the diagram you selected. On the Plutonic QAPF diagram they read Quartz / Alkali Feldspar / Plagioclase; on the Ultramafic Ol–Opx–Cpx diagram they read Olivine / Orthopyroxene / Clinopyroxene; on the carbonatite diagram they read CaO wt % / MgO wt % / $FeO+Fe_2O_3+MnO$ wt %. **Always read the labels before typing.** The full label set is given in Table 5.2.

The boxes accept any non-negative number, including decimals. They must sum to more than zero. Values are normalised to 100 % before classification, so absolute magnitudes do not matter — only the ratios.

4.3 Optional — Additional Data

This panel appears only when at least one of its three boxes is relevant to the current diagram, and each box shows or hides itself independently:

Box	Shown for	What it does
Plagioclase An content (An %)	Plutonic QAPF, Plutonic Foid	An > 50 selects the gabbroic name (Gabbro, Monzogabbro, Quartz Gabbro, Foid Gabbro…); An ≤ 50 or blank selects the dioritic name (Diorite, Monzodiorite…). Blank is treated as dioritic.
Mafic minerals (vol % of rock)	Plutonic QAPF, Volcanic QAPF, Plutonic Foid, Volcanic Foid, Charnockites	The colour index M. Drives the anorthosite test (< 10), the ultramafic test (≥ 90), and the andesite / basalt split. Blank means the test is skipped.

Box	Shown for	What it does
Olivine (% of mafics)	Plutonic QAPF, Volcanic Foid	On the plutonic diagram, splits the M ≥ 90 ultramafic field into pyroxenite / peridotite / dunite. On the volcanic foid diagram, splits tephrite from basanite and phonolitic tephrite from phonolitic basanite at 10 %. Blank is treated as zero.

> This is *olivine as a percentage of the mafic minerals*, not of the whole rock. A rock with M = 60 of which half is olivine has 30 % olivine by volume but you enter `50`.

4.4 The Classify Rock button and result panel

Clicking *Classify Rock* validates the three inputs and then evaluates the composition. The result panel that appears has three lines:

- **Line 1** — the diagram used, e.g. "Plutonic QAPF (Q–A–P)". Confirm this is the diagram you intended.
- **Line 2** — the rock name in large bold type, or a message in dark red if something went wrong.
- **Line 3** — the normalised end-member values to one decimal place. Copy these into your log.

The panel is cleared automatically whenever you change the rock group or the diagram, so a stale result can never be mistaken for a current one. Changing a mineral percentage does *not* clear it — click *Classify Rock* again after each edit.

4.5 Question mode (Back / Next)

For rock groups and sub-groups that are not classified on a ternary diagram, Step 2 is replaced by a *Questions* panel: a question in bold, a list of radio buttons, and *< Back* and *Next >* buttons. Select one option and click *Next >*. Depending on the branch, you will either be asked a follow-up question or shown the result immediately.

- *< Back* is greyed out on the first question and becomes active once you have gone at least one level deep. It returns you to the previous question with your earlier answers intact.
- If you click *Next >* without selecting anything, the result panel shows the reminder `Please select an option, then click Next.` in dark red. Choose an option and click again.
- Two trees — Evaporites and Phosphorites — have no questions at all and display their result the moment you select them.
- A successful result is prefixed with the group name and the message "Congratulations!! You have successfully classified your rock", and many results carry a note suggesting a further classification table.

Figure 3 — Question mode. Selecting Metamorphic Rock Group hides the diagram drop-down and the mineral boxes entirely, and opens the first question.

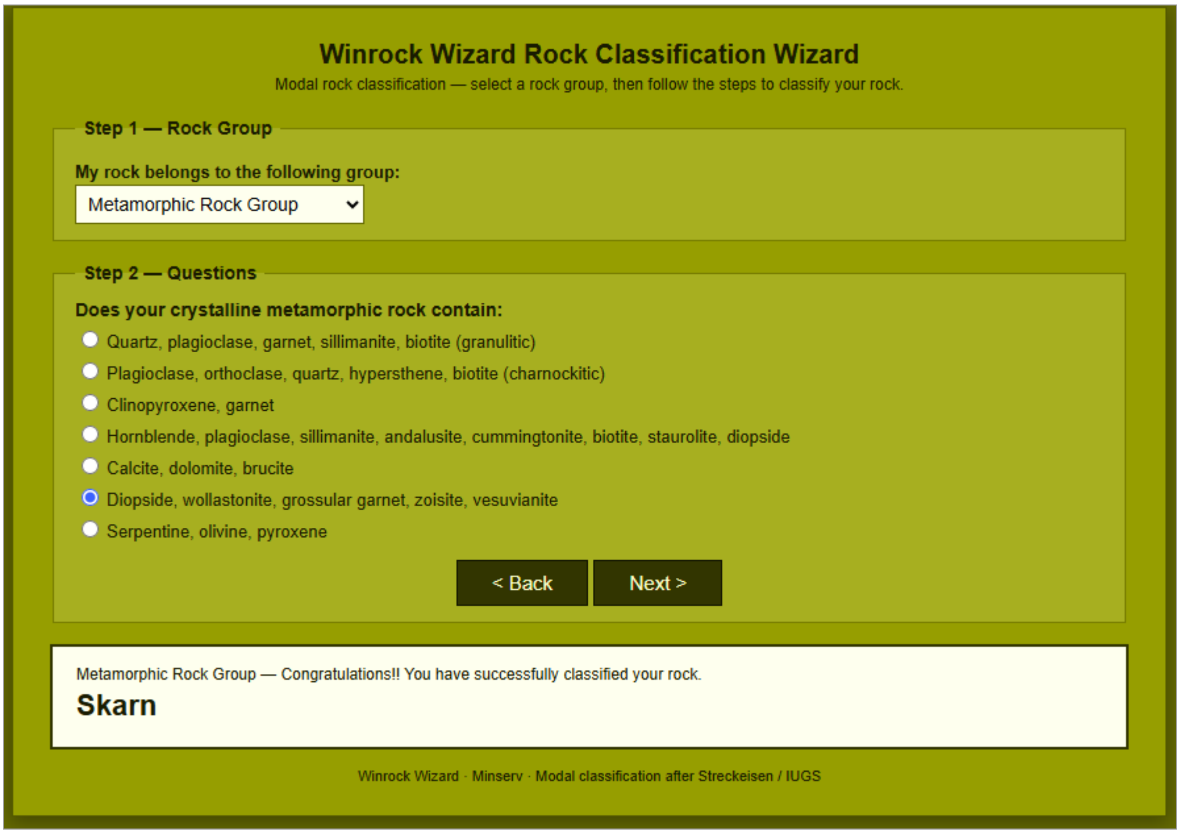

Figure 4 — A result reached from a second-level question. Answering "Crystalline" then choosing the diopside–wollastonite–grossular assemblage returns Skarn.

5. Choosing the Right Diagram

5.1 Decision guide

Choosing the diagram is the single most consequential decision you make, because every diagram will happily return a name for any composition you feed it. Work through the following in order.

1. **Is it igneous, sedimentary, metamorphic, a duricrust or a meteorite?** Set the rock group accordingly. If it is metamorphic, a duricrust or a meteorite, you are done choosing — answer the questions.
2. **If igneous: is it a lamprophyre, a pyroclastic rock, a carbonatite or a melilite-bearing rock?** These are special cases and take priority over QAPF. Select them from *Other Igneous*.
3. **Is the colour index M ≥ 90?** The rock is ultramafic. Use *Ultramafic Ol–Opx–Cpx* if the mafics are essentially olivine and pyroxenes; use *Ultramafic Ol–Px–Hbl* if hornblende is a significant phase.
4. **Is the rock in the plagioclase corner with M between 10 and 90 — i.e. a gabbro, norite or troctolite?** The QAPF triangle will only tell you "gabbro" or "diorite". Use *Gabbroic Plag–Px–Ol* to resolve norite / gabbronorite / gabbro / troctolite, or *Gabbroic Plag–Px–Hbl* where hornblende rather than olivine is the second mafic.
5. **Does the rock carry orthopyroxene (hypersthene) in a granitoid assemblage?** Use *Charnockites*.
6. **Otherwise: does it contain quartz, or foids?** Quartz → a QAPF diagram; foids → an FAP diagram. If it contains neither in appreciable amount, use QAPF with Q = 0.
7. **Finally: is it plutonic or volcanic?** Coarse, phaneritic, holocrystalline → plutonic. Fine grained, porphyritic, glassy or vesicular → volcanic. This choice changes the entire name set — trachyte versus syenite, rhyolite versus granite — so decide it on texture before you classify, not after.

> **If you cannot obtain a reliable mode** because the rock is glassy, aphanitic or heavily altered, do not force a volcanic QAPF determination. Use the chemical TAS classification instead; the wizard does not implement it.

5.2 Diagram index

The table below lists every diagram in the wizard, the labels its three input boxes take, and which optional boxes it uses.

Group	Diagram	Box 1	Box 2	Box 3	Optional boxes used
Igneous	Plutonic QAPF (Q–A–P)	Quartz %	Alkali Feldspar %	Plagioclase %	An %, Mafics, Olivine
Igneous	Volcanic QAPF (Q–A–P)	Quartz %	Alkali Feldspar %	Plagioclase %	Mafics
Igneous	Plutonic Foid (F–A–P)	Foid %	Alkali Feldspar %	Plagioclase %	An %, Mafics
Igneous	Volcanic Foid (F–A–P)	Foid %	Alkali Feldspar %	Plagioclase %	Mafics, Olivine
Igneous	Gabbroic Plag–Px–Ol	Plagioclase %	Pyroxene %	Olivine %	none
Igneous	Gabbroic Plag–Px–Hbl	Plagioclase %	Pyroxene %	Hornblende %	none
Igneous	Ultramafic Ol–Opx–Cpx	Olivine %	Orthopyroxene %	Clinopyroxene %	none
Igneous	Ultramafic Ol–Px–Hbl	Olivine %	Pyroxene %	Hornblende %	none

Group	Diagram	Box 1	Box 2	Box 3	Optional boxes used
Igneous	Charnockites (Q–A–P)	Quartz %	K Feldspar %	Plagioclase %	Mafics
Igneous	Carbonatites	CaO wt %	MgO wt %	$FeO+Fe_2O_3+MnO$ wt %	none
Igneous	Melilite Plutonic	Melilite %	Olivine %	Clinopyroxene %	none
Igneous	Melilite Volcanic	Melilite %	Olivine %	Clinopyroxene %	none
Igneous	Pyroclastics	Question tree — predominant clast size			—
Igneous	Lamprophyres	Question tree — felsic and mafic mineralogy			—
Sedim.	Sandstones (Q–R–F)	Quartz %	Rock Fragments + Matrix %	Feldspar %	none
Sedim.	Wackes (Q–R–F)	Quartz %	Rock Fragments %	Feldspar %	none
Sedim.	Mudstones, Limestones, Coals, Evaporites, Phosphorites, Volcaniclastics, Conglomerates	Question trees			—

6. Preparing Your Modal Data

6.1 Point counting and visual estimation

A modal analysis is only as good as the counting behind it. For publication-quality work, point count a stained thin section or slab on a regular grid: 500 points gives a standard error of roughly ±2 % absolute on a phase present at 20 %, 1000 points about ±1.5 %. For field or logging work, visual estimation against comparison charts is normally adequate — the IUGS fields are wide enough that a ±5 % estimate rarely changes the root name except close to a boundary.

Two practical points:

- **Stain for K-feldspar.** Distinguishing alkali feldspar from plagioclase by eye is the single largest source of error in QAPF work, and it moves the point horizontally — the direction that separates syenite from monzonite from diorite. Sodium cobaltinitrite staining after HF etch is quick and decisive.
- **Count perthite carefully.** Coarse perthite should in principle be split between A and P; fine, submicroscopic perthite is counted wholly as A. Be consistent and record what you did.

6.2 What goes into Q, A and P

End member	Include	Exclude
Q	Quartz, tridymite, cristobalite	Chalcedony and secondary silica in veins or amygdales
A	Orthoclase, microcline, sanidine, anorthoclase, perthite, albite up to An_5	Sericite and other alteration products of feldspar
P	Plagioclase An_5–An_{100}, scapolite	Saussurite and epidote replacing plagioclase (count as the original plagioclase if the texture is clear)
F	Nepheline, leucite, sodalite, nosean, haüyne, cancrinite, analcime (primary), pseudo-leucite	Zeolites of clearly secondary origin
M (optional box)	Olivine, pyroxenes, amphiboles, micas, opaques, garnet, melilite, monticellite, carbonate, apatite, zircon and all other accessories	Nothing — M is everything that is not Q, A, P or F

6.3 Recalculating to the three end members

You do not need to. The wizard normalises for you, and it reports the values it used. If you prefer to check the arithmetic by hand:

```
sum = Q + A + P  →  Q′ = 100 Q / sum, A′ = 100 A / sum, P′′ = 100 P / sum
```

and the horizontal coordinate that the field boundaries are quoted against is

```
P′ = 100 × P / (A + P)   (equivalently 100 × P′′ / (A′ + P′′))
```

Note the two distinct quantities: `P′′` is plagioclase as a percentage of the whole QAP sum, and `P′` is plagioclase as a percentage of the total feldspar. The wizard's result line reports P″; the field tables in §7 are indexed on P′.

6.4 Measuring An content

The An box takes the anorthite molecule percentage of the plagioclase — An_{50} is entered as `50`. Determine it by the Michel-Lévy maximum extinction-angle method on albite twins, by the a-normal or Carlsbad–albite methods, or from microprobe analysis. The wizard uses a single test, `An > 50`, to choose between the gabbroic and dioritic name series. Because the boundary is sharp, take care with plagioclase in the An_{45}–An_{55} range and record which method you used.

6.5 Estimating M and the olivine fraction

M is a whole-rock quantity: count every non-felsic phase and express the total as a volume percentage of the entire rock. The olivine box is different — it is olivine as a percentage of M, not of the rock. If you counted 55 % olivine, 38 % pyroxene and 7 % plagioclase in an ultramafic rock, then M = 93 and the olivine fraction is 55 / 93 = 59 %.

7. Igneous Diagram Reference

Each diagram below is documented as a complete field table. The tables are exhaustive — every rock name the wizard can return from that diagram appears, together with the exact numerical field it occupies. Unless stated otherwise, **Q** and **F** are the normalised apex percentages reported on the wizard's result line, and **P′** is the plagioclase ratio `100 × P / (A + P)`.

> Field limits are inclusive at both ends in the wizard's arithmetic, so a composition landing exactly on a boundary satisfies the tests for both adjacent fields. The tie is broken by evaluation order — see §11. Ranges in the tables are written as the ideal IUGS boundaries; §11 tells you which side of the line the wizard actually lands on.

7.1 Plutonic QAPF (Q–A–P)

Uses: An %, Mafics, Olivine. The classic Streckeisen plutonic field diagram. Horizontal divisions at Q = 5, 20, 60 and 90; vertical divisions at P′ = 10, 35, 65 and 90.

Q	P′	Rock name	Modifiers
0 – 5	0 – 10	Alkali Feldspar Syenite	
0 – 5	10 – 35	Syenite	
0 – 5	35 – 65	Monzonite	
0 – 5	65 – 90	Monzodiorite (An ≤ 50 or blank) Monzogabbro (An > 50)	An % decides
0 – 5	90 – 100	Diorite (An ≤ 50 or blank) Gabbro (An > 50) **Anorthosite** if M < 10 **Pyroxenite or Hornblendite** if M ≥ 90 and Ol < 40 **Peridotite** if M ≥ 90 and Ol 40–90 **Dunite** if M ≥ 90 and Ol ≥ 90	An %, then M, then Olivine (% of mafics). M tests override the An result.
5 – 20	0 – 10	Quartz Alkali Feldspar Syenite	
5 – 20	10 – 35	Quartz Syenite	
5 – 20	35 – 65	Quartz Monzonite	
5 – 20	65 – 90	Quartz Monzodiorite (An ≤ 50) / Quartz Monzogabbro (An > 50)	An % decides
5 – 20	90 – 100	Quartz Diorite (An ≤ 50) / Quartz Gabbro (An > 50) **Quartz Anorthosite** if M < 10	An %, then M
20 – 60	0 – 10	Alkali Feldspar Granite	
20 – 60	10 – 35	Syenogranite	
20 – 60	35 – 65	Monzogranite	
20 – 60	65 – 90	Granodiorite	An % is *not* used here
20 – 60	90 – 100	Tonalite	Includes trondhjemite
60 – 90	any	Quartz Rich Granitoids	Whole band, regardless of P′
90 – 100	any	Quartzolite	Silexite

7.2 Volcanic QAPF (Q–A–P)

Uses: Mafics only. The volcanic equivalents of the plutonic names. The M threshold for andesite versus basalt on this diagram is **35**.

Q	P′	Rock name	Modifiers
0 – 5	0 – 10	Alkali Feldspar Trachyte	
0 – 5	10 – 35	Trachyte	
0 – 5	35 – 65	Latite	
5 – 20	0 – 10	Quartz Alkali Feldspar Trachyte	Strict: 5 < Q < 20
5 – 20	10 – 35	Quartz Trachyte	
5 – 20	35 – 65	Quartz Latite	
0 – 20	65 – 100	Andesite (M ≤ 35 or blank) Basalt (M > 35)	Mafics box decides; blank is treated as M = 0, i.e. andesite
20 – 60	10 – 65	Rhyolite	
20 – 60	65 – 100	Dacite	
20 – 60	0 – 10	*No field defined* — see §12.2	
60 – 100	any	*No field defined* — see §12.2	

7.3 Plutonic Foid (F–A–P)

Uses: An %, Mafics. Horizontal divisions at F = 10 and 60; the vertical division inside the foid-rich band sits at P′ = 50, not 35/65.

F	P′	Rock name	Modifiers
0 – 10	0 – 10	Foid-Bearing Alkali Feldspar Syenite	
0 – 10	10 – 35	Foid-Bearing Syenite	
0 – 10	35 – 65	Foid-Bearing Monzonite	
0 – 10	65 – 90	Foid-Bearing Monzodiorite (An ≤ 50) / Foid-Bearing Monzogabbro (An > 50)	An %
0 – 10	90 – 100	Foid-Bearing Diorite (An ≤ 50) / Foid-Bearing Gabbro (An > 50) **Foid-Bearing Anorthosite** if M ≤ 10	An %, then M
10 – 60	0 – 10	Foid Syenite	Nepheline syenite, sodalite syenite etc.
10 – 60	10 – 50	Foid Monzosyenite	Plagifoyaite
10 – 60	50 – 90	Foid Monzodiorite (An ≤ 50) / Foid Monzogabbro (An > 50)	An %; essexite, theralite
10 – 60	90 – 100	Foid Diorite (An ≤ 50) / Foid Gabbro (An > 50)	An %
60 – 100	any	Foidolite	Ijolite, urtite, melteigite series

7.4 Volcanic Foid (F–A–P)

Uses: Mafics, Olivine. Note two thresholds that differ from the other diagrams: the andesite/basalt split uses **M = 50** here (not 35), and the tephrite/basanite split uses **olivine = 10 % of the mafics**.

F	P′	Rock name	Modifiers
0 – 10	0 – 10	Foid-Bearing Alkali Feldspar Trachyte	

F	P′	Rock name	Modifiers
0 – 10	10 – 35	Foid-Bearing Trachyte	
0 – 10	35 – 65	Foid-Bearing Latite	
0 – 10	65 – 100	Andesite (M ≤ 50 or blank) / Basalt (M > 50)	Mafics
10 – 60	0 – 10	Phonolite	
10 – 60	10 – 50	Tephritic Phonolite	
10 – 60	50 – 90	Phonolitic Tephrite (Ol ≤ 10) / Phonolitic Basanite (Ol > 10)	Olivine (% of mafics)
10 – 60	90 – 100	Tephrite (Ol ≤ 10 or blank) / Basanite (Ol > 10)	Olivine (% of mafics)
60 – 90	0 – 50	Phonolitic Foidite	
60 – 90	50 – 100	Tephritic Foidite	
90 – 100	any	Foidite	Nephelinite, leucitite, analcimite

7.5 Gabbroic Plag–Px–Ol

No optional boxes. Enter plagioclase, total pyroxene and olivine as percentages of those three phases only. The horizontal coordinate is normalised plagioclase; the vertical coordinate the wizard uses is the olivine ratio `Ol′ = 100 × Ol / (Px + Ol)`.

Plagioclase	Ol′	Rock name
0 – 10	any	Ultramafic Rock — re-classify on an ultramafic diagram
10 – 35	0 – 5	Norite
10 – 35	5 – 90	Olivine Norite
35 – 65	0 – 5	Gabbronorite
35 – 65	5 – 90	Olivine Gabbronorite
65 – 90	0 – 5	Gabbro
65 – 90	5 – 90	Olivine Gabbro
10 – 90	90 – 100	Troctolite
90 – 100	any	Anorthosite

> Norite, gabbronorite and gabbro are distinguished in the published IUGS scheme by the orthopyroxene : clinopyroxene ratio, not by the plagioclase content. In this diagram the wizard uses plagioclase as the horizontal axis, so the three names are separated by plagioclase content instead. Treat the norite / gabbronorite / gabbro output as indicative and confirm the pyroxene ratio petrographically.

7.6 Gabbroic Plag–Px–Hbl

No optional boxes. Vertical coordinate is the hornblende ratio `Hbl′ = 100 × Hbl / (Px + Hbl)`.

Plagioclase	Hbl′	Rock name
0 – 10	0 – 10	Plagioclase Bearing Pyroxenite
0 – 10	10 – 50	Plagioclase Bearing Hornblende Pyroxenite
0 – 10	50 – 90	Plagioclase Bearing Pyroxene Hornblendite
0 – 10	90 – 100	Plagioclase Bearing Hornblendite

Plagioclase	Hbl′	Rock name
10 – 35	0 – 5	Norite
10 – 35	5 – 90	Pyroxene Hornblende Norite
35 – 65	0 – 5	Gabbronorite
35 – 65	5 – 90	Pyroxene Hornblende Gabbronorite
65 – 90	0 – 5	Gabbro
65 – 90	5 – 90	Pyroxene Hornblende Gabbro
10 – 90	90 – 100	Hornblende Gabbro
90 – 100	any	Anorthosite

7.7 Ultramafic Ol–Opx–Cpx

No optional boxes. For rocks with M ≥ 90 in which the mafics are olivine and pyroxenes. Vertical coordinate is `Opx′ = 100 × Opx / (Opx + Cpx)`: **Opx′ = 100 is pure orthopyroxene, Opx′ = 0 is pure clinopyroxene.**

Olivine	Opx′	Rock name
90 – 100	any	Dunite
40 – 90	95 – 100	Harzburgite
40 – 90	5 – 95	Lherzolite
40 – 90	0 – 5	Wehrlite
5 – 40	95 – 100	Olivine Orthopyroxenite
5 – 40	5 – 95	Olivine Websterite
5 – 40	0 – 5	Olivine Clinopyroxenite
0 – 5	90 – 100	Orthopyroxenite
0 – 5	10 – 90	Websterite
0 – 5	0 – 10	Clinopyroxenite

7.8 Ultramafic Ol–Px–Hbl

No optional boxes. For ultramafic rocks in which hornblende is a major phase. Vertical coordinate is `Hbl′ = 100 × Hbl / (Px + Hbl)`.

Olivine	Hbl′	Rock name
0 – 10	0 – 10	Pyroxenite
0 – 10	10 – 50	Hornblende Pyroxenite
0 – 10	50 – 90	Pyroxene Hornblendite
0 – 10	any, with Px ≤ 10	Hornblendite (this test overrides the three above)
10 – 40	0 – 5	Olivine Pyroxenite
10 – 40	5 – 50	Olivine Hornblende Pyroxenite
10 – 40	50 – 95	Olivine Pyroxene Hornblendite
10 – 40	95 – 100	Olivine Hornblendite
40 – 90	0 – 5	Pyroxene Peridotite
40 – 90	5 – 95	Pyroxene Hornblende Peridotite

Olivine	Hbl′	Rock name
40 – 90	95 – 100	Hornblende Peridotite
90 – 100	any	Dunite

7.9 Charnockites (Q–A–P)

Uses: Mafics. The orthopyroxene-bearing granitoid series of granulite-facies terranes. Box 2 is labelled *K Feldspar %* rather than Alkali Feldspar, but is treated identically. Horizontal divisions at Q = 20 and 60; vertical divisions at P′ = 10, 35, 65 and 90.

Q	P′	Rock name	Modifiers
0 – 20	0 – 10	Hypersthene Alkali Feldspar Syenite	
0 – 20	10 – 35	Hypersthene Syenite	
0 – 20	35 – 65	Mangerite	Hypersthene monzonite
0 – 20	65 – 90	Jotunite	Hypersthene monzodiorite
0 – 20	90 – 100	Norite **Anorthosite** if M < 10	Mafics
20 – 60	0 – 10	Alkali Feldspar Charnockite	
20 – 60	10 – 65	Charnockite	Hypersthene granite
20 – 60	65 – 90	Opdalite or Charno-enderbite	Hypersthene granodiorite
20 – 60	90 – 100	Enderbite	Hypersthene tonalite
60 – 100	any	*No field defined* — see §12.2	

7.10 Carbonatites

No optional boxes. The only chemical diagram in the wizard. Enter oxide weight percentages; they are normalised to 100 % as usual.

Condition (on normalised values)	Rock name
CaO ≥ 80	Calciocarbonatite (sövite, alvikite)
CaO < 80 and MgO ≥ FeO+Fe_2O_3+MnO	Magnesiocarbonatite (beforsite)
CaO < 80 and MgO < FeO+Fe_2O_3+MnO	Ferrocarbonatite

A carbonatite is defined as an igneous rock containing more than 50 modal % primary carbonate and less than 20 wt % SiO_2. Establish that first; this diagram then subdivides it. A rock with more than 20 wt % SiO_2 is a silicocarbonatite and falls outside the diagram.

7.11 Melilite-bearing Plutonic (Mel–Ol–Cpx)

No optional boxes. The vertical coordinate is `Cpx′ = 100 × Cpx / (Ol + Cpx)`. Two sloping field lines run across the diagram between melilite 10 and 90:

$$b_1 = 11 + 89 \times (Mel - 10) / 80 \qquad b_2 = 89 \times (90 - Mel) / 80$$

Condition	Rock name
Mel > 90	Melilitolite
Mel 10 – 90, Cpx′ below both lines	Olivine Melilitolite (Kugdite)
Mel 10 – 90, Cpx′ above both lines	Pyroxene Melilitolite (Uncompahgrite)

Condition	Rock name
Mel 10 – 90, Cpx′ between the lines and ≤ 50	Pyroxene Olivine Melilitolite
Mel 10 – 90, Cpx′ between the lines and > 50	Olivine Pyroxene Melilitolite (Olivine Uncompahgrite)
Mel < 10, olivine > 40	Melilite-bearing Peridotite
Mel < 10, olivine ≤ 40	Melilite-bearing Pyroxenite

7.12 Melilite-bearing Volcanic (Mel–Ol–Cpx)

No optional boxes. A single sloping field line, `b = 89 × (90 − Mel) / 80`, with `Cpx′ = 100 × Cpx / (Ol + Cpx)` as before.

Condition	Rock name
Mel ≥ 10, Cpx′ > b	Melilitite
Mel ≥ 10, Cpx′ ≤ b	Olivine Melilitite
Mel < 10, olivine > 40	Melilite-bearing Peridotite
Mel < 10, olivine ≤ 40	Melilite-bearing Pyroxenite

Because b falls to zero at Mel = 90, every composition with more than about 90 % melilite returns Melilitite regardless of the olivine : clinopyroxene ratio.

8. Sedimentary Diagram Reference

8.1 Sandstones (Q–R–F)

No optional boxes. Box 2 is *Rock Fragments + Matrix*. All three values are normalised to 100 % and the fields are tested in the order shown, so a later match overrides an earlier one.

Q	F	R	Rock name
0 – 25	0 – 25	50 – 100	Mudstone
25 – 85	0 – 25	any	Quartz Wacke
0 – 75	25 – 60	any	Greywacke
40 – 75	> 25	any	Arkose
75 – 95	5 – 25	any	SubArkose (strict: F > 5 and F < 25)
> 95	any	any	Quartz Arenite
85 – 95	0 – 5	any	*No field defined* — see §12.2
0 – 40	> 60	any	*No field defined* — see §12.2

Figure 5 — The sandstone diagram. The same numbers used in Figure 2 return Greywacke here, which is exactly why choosing the right diagram matters.

8.2 Wackes (Q–R–F)

No optional boxes. Box 2 is *Rock Fragments* (matrix excluded). A simple three-field split.

Q	R	Rock name
0 – 95	0 – 50	Feldspathic Wacke
0 – 95	50 – 100	Lithic Wacke

Q	R	Rock name
> 95	any	Quartz Wacke

Use this diagram only for a rock already established as a wacke, i.e. containing more than about 15 % fine-grained matrix. For a matrix-poor arenite use the Sandstones diagram.

9. Question-Tree Reference

Nine of the wizard's classification paths use questions rather than a ternary diagram. This section documents every question, every option and every outcome, so that you can see the whole tree at once rather than discovering it one click at a time.

9.1 Metamorphic Rock Group

Q1 — Is your metamorphic rock:

Answer	Result
Foliated	→ go to Q2 (below)
Crystalline	→ go to Q3 (below)
Microcrystalline	**Hornfels** — identify the metamorphic minerals and name it accordingly, e.g. Cordierite Hornfels
Mixed (migmatitic)	**Migmatite**
Partially recrystallized (meta-)	→ go to Q4 (below)

Q2 — Is your foliated metamorphic rock:

Answer	Result
Schistose	**Schist** — identify the major minerals and name accordingly, e.g. Mica Schist
Slaty	**Phyllite or Slate**
Foliated / banded	**Gneiss**
Crushed and/or recrystallized	**Mylonite** — a dynamometamorphic rock; use the dynamometamorphic table to classify further

Q3 — Does your crystalline metamorphic rock contain:

Assemblage	Result
Quartz, plagioclase, garnet, sillimanite, biotite (granulitic)	**Granulite** — name for the major minerals, e.g. Garnet Granulite
Plagioclase, orthoclase, quartz, hypersthene, biotite (charnockitic)	**Charnockite** — use the Charnockite diagram (§7.9) to classify further
Clinopyroxene, garnet	**Eclogite**
Hornblende, plagioclase, sillimanite, andalusite, cummingtonite, biotite, staurolite, diopside	**Amphibolite**
Calcite, dolomite, brucite	**Marble**
Diopside, wollastonite, grossular garnet, zoisite, vesuvianite	**Skarn**
Serpentine, olivine, pyroxene	**Serpentinite**

Q4 — Is your meta- rock:

Answer	Result
Argillaceous	**Pelitic Meta-Sediment (Pelite)**
Arenaceous	**Psammitic Meta-Sediment (Psammite)**

Answer	Result
Conglomeratic	**Meta-Conglomerate**
Obviously volcanic	**Meta-Volcanic** — prefix the igneous name with Meta-, e.g. Meta-Basalt
Obviously igneous	**Meta-Igneous Rock** — e.g. Meta-Gabbro
Banded chert / hematite / magnetite	**Banded Iron Formation**
Cherty	**Chert**
Quartzose	**Quartzite**
Olivine, pyroxene, serpentine	**Serpentinite, Peridotite or Komatiite**

9.2 Duricrust Rock Group

Q1 — Is your duricrust composed of:

Answer	Result
Iron oxide minerals	→ Q2 — *Is your duricrust rock: Pisolitic* → **Laterite**; *Other* → **Ironstone**
SiO_2 (silica)	**Silcrete**
Colluvium	**Colluvium**
Calcium carbonate	**Calcrete**

Figure 6 — The duricrust tree opens directly on its first question; no diagram drop-down is offered.

9.3 Meteorites Rock Group

Q1 — Select the composition that best matches your meteorite:

Composition	Result
Iron / nickel alloys + graphite	**Iron Meteorite**
Olivine / pyroxenes / plagioclase	**Stony Meteorite (Achondrite)**
Iron / nickel alloys + olivine + pyroxenes	**Stony Iron Meteorite**
Olivine / pyroxenes / plagioclase mineral aggregates (chondrules)	**Stony Meteorite (Chondrite)**

Composition	Result
Carbonaceous + mineral aggregates (chondrules)	**Carbonaceous Chondrite Meteorite**

All five results carry the note that the meteorite can be further classified using the Meteorite Classification Table.

9.4 Pyroclastics (Igneous → Other Igneous)

Q1 — What is the predominant clast size of your pyroclastic rock?

Clast size	Result	Note
> 64 mm (bomb, block)	**Agglomerate or Pyroclastic Breccia**	Agglomerate if rounded bombs predominate; pyroclastic breccia if angular blocks predominate. Unconsolidated equivalent: bomb / block tephra
2 – 64 mm (lapillus)	**Lapilli Tuff**	Unconsolidated equivalent: lapilli tephra
1/16 – 2 mm (coarse ash)	**Coarse (Ash) Tuff**	Unconsolidated equivalent: coarse ash
< 1/16 mm (fine ash)	**Fine (Ash) Tuff**	Also called dust tuff. Unconsolidated equivalent: fine ash (dust)

9.5 Lamprophyres (Igneous → Other Igneous)

A four-level tree keyed on the felsic minerals first, then the feldspar that predominates, then the predominant mafic mineral.

Q1 — Which felsic minerals does your lamprophyre contain?

Answer	Result
Feldspar only (foids absent)	→ Q2a
Feldspar with subordinate foid or glass	→ Q2b
Foid only (feldspar absent)	→ Q2c
Neither feldspar nor foid	**Alnöite** — melilitic lamprophyre, colour index > 70 %; matrix biotite ± titanaugite ± olivine, melilite

Q2a — Which feldspar predominates? (feldspar only) — followed in each case by Which is the predominant mafic mineral?

Feldspar	Predominant mafic	Result
Orthoclase > plagioclase	Biotite (+ diopside, ± olivine)	**Minette** — calc-alkaline, CI > 35 %
	Hornblende (+ diopside, ± olivine)	**Vogesite** — calc-alkaline, CI > 35 %
Plagioclase > orthoclase	Biotite (+ augite, ± olivine)	**Kersantite** — calc-alkaline, CI > 35 %
	Hornblende (+ augite, ± olivine)	**Spessartite** — calc-alkaline, CI > 35 %

Q2b — Which feldspar predominates? (feldspar with subordinate foid or glass)

Answer	Result
Orthoclase > plagioclase	**Sannaite** — alkaline lamprophyre; amphibole / titanaugite ± olivine ± biotite, CI > 40 %
Plagioclase > orthoclase	**Camptonite** — alkaline lamprophyre, CI > 40 %

Q2c — Which are the predominant mafic minerals? (foid only)

Answer	Result
Amphibole / titanaugite (± olivine, ± biotite)	**Monchiquite** — alkaline lamprophyre, CI > 40 %
Melilite + biotite (± titanaugite, ± olivine)	**Polzenite** — melilitic lamprophyre, CI > 70 %

9.6 Mudstones (Sedimentary → Other Sedimentary)

Q1 — What is the clay-sized composition of your rock?

Clay-sized fraction	Result
0 – 32 % clay	**Siltstone**
32 – 65 % clay	**Mudstone**
66 – 100 % clay	**Claystone**
66 – 100 % clay, laminated	**Shale**

All four results note that the rock can be further classified using the Mudstone classification table.

9.7 Limestones (Sedimentary → Other Sedimentary)

Q1 — Select the composition that best matches your limestone:

Composition	Result
Calcium carbonate mud (micrite)	**Micrite**
Calcium carbonate cement (sparite)	**Sparite**
Calcium carbonate grains	**Grainstone**
Ooids	**Oolite**
Pellets	**Pelloidite**
Intraclasts	**Intrasparite or Intramicrite** — intrasparite if predominantly cement, intramicrite if predominantly mud matrix
Shelly / coral material bound together	**Boundstone**
Calcium carbonate tests (chalk)	**Chalk**
A mixture of any of the above	→ Q2

Q2 — Select the composition that best matches your limestone:

Composition	Result
Micrite + sparite (micsparite)	**Micsparite**
Micrite / sparite + pellets	**Pelmicsparite**
Micrite / sparite + ooids	**Oomicsparite**
Micrite / sparite + shelly / coral material	**Biomicsparite**
Micrite / sparite + intraclasts	**Intramicsparite**
Other	**Limestone (unclassified mixture)** — use the Limestone classification table

9.8 Coals, Evaporites and Phosphorites

Path	Question	Results
Coals	Is your coal: Brown / Black / Peaty	**Brown Coal** / **Black Coal** / **Peat**
Evaporites	*none*	**Evaporite** — displayed immediately. Name the rock for its mineralogy, e.g. anhydrite, gypsum, halite
Phosphorites	*none*	**Phosphorite** — displayed immediately. Use the Phosphorite classification table to classify further

9.9 Volcaniclastics / Epiclastics (Sedimentary → Other Sedimentary)

Q1 — What is the composition of your volcaniclastic rock?

Pyroclastic content	Result
75 – 100 % pyroclastic material	→ the pyroclastic clast-size question (§9.4)
25 – 75 % pyroclastic material	→ Q2 below (tuffites)
0 – 25 % pyroclastic material	**Clastic Sediment** — mostly normal clastic sediment; classify under Sandstones, Mudstones or Conglomerates instead

Q2 — What is the size of the clasts in your volcaniclastic rock? All results are tuffites, i.e. mixed pyroclastic–epiclastic rocks.

Clast size	Result
> 64 mm	**Tuffaceous Conglomerate or Breccia**
2 – 64 mm	**Tuffaceous Conglomerate or Breccia**
1/16 – 2 mm	**Tuffaceous Sandstone**
1/256 – 1/16 mm	**Tuffaceous Siltstone**
< 1/256 mm	**Tuffaceous Mudstone or Shale**

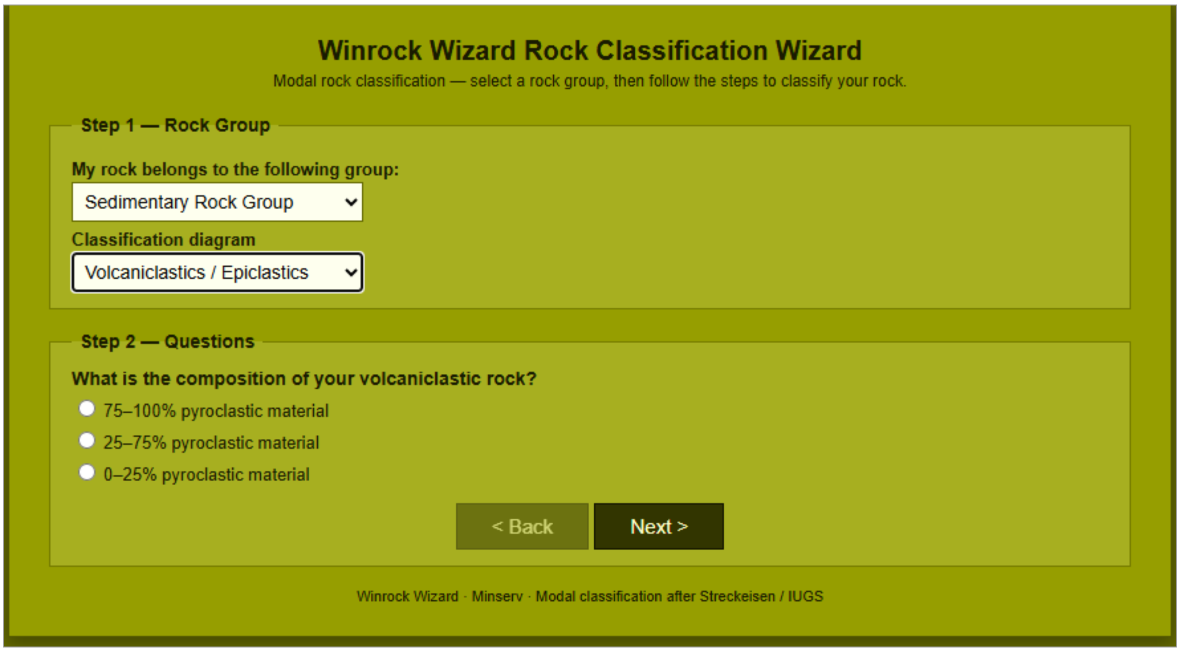

Figure 7 — The volcaniclastic tree. Selecting "75–100 % pyroclastic material" hands off to the pyroclastic clast-size question.

9.10 Conglomerates and Breccias (Sedimentary → Other Sedimentary)

Q1 — What group does your conglomerate belong to?

Group	Result
Sedimentary, extraformational	→ Q2 below
Sedimentary, intraformational	**Intraformational Conglomerate or Breccia**
Pyroclastic	**Volcanic Breccia or Agglomerate**
Cataclastic	**Fault/Fold, Landslide or Solution Breccia**
Meteoric	**Impact Breccia**

Q2 — What is the composition of your conglomerate?

Matrix	Result
Matrix < 15 %	**Orthoconglomerate**
Matrix > 15 %, non-glacial	**Paraconglomerate**
Matrix > 15 %, glacial	**Tillite**

All results note that the rock can be further classified using the Conglomerate classification table.

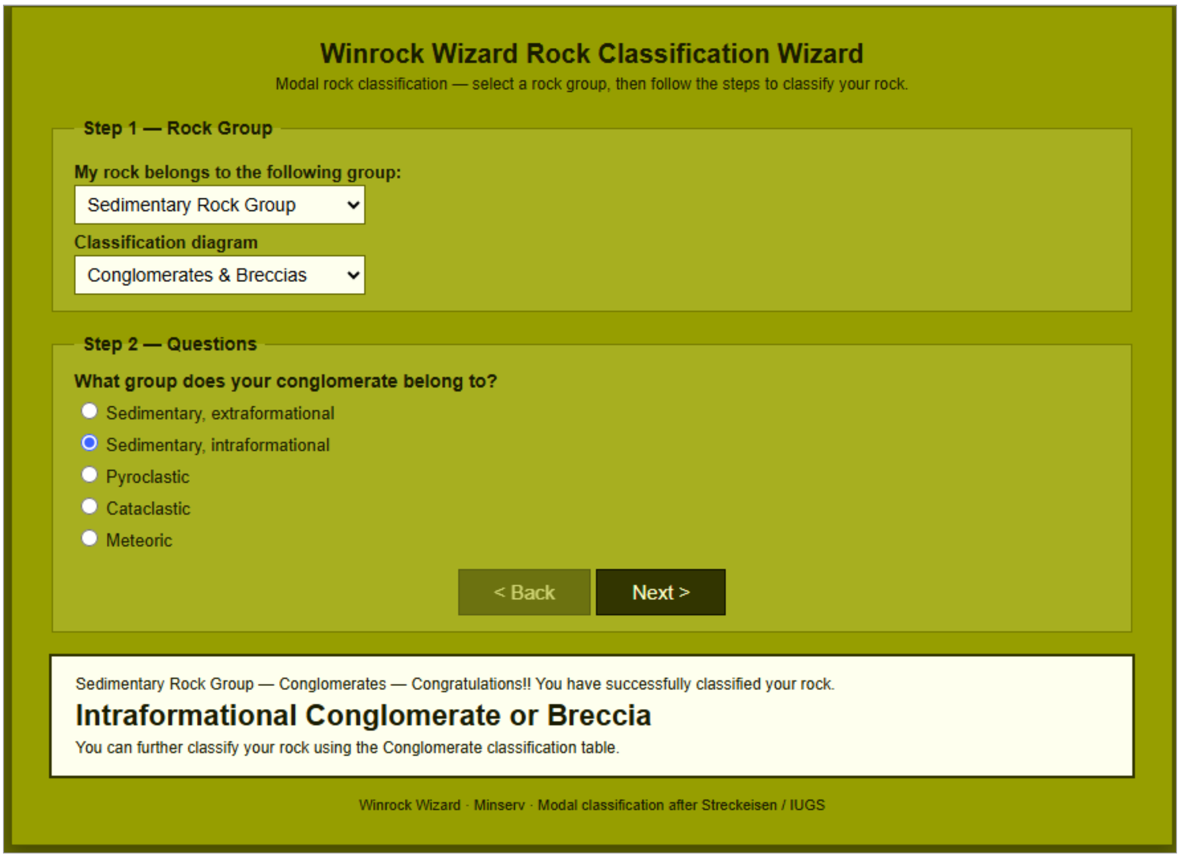

Figure 8 — A conglomerate classified from the first question. Note that the result panel names both the group and the sub-group used.

10. Worked Examples

10.1 Example 1 — a granitoid

A coarse, equigranular, pale grey plutonic rock. Point count: quartz 30, alkali feldspar 31, plagioclase 22, biotite 12, hornblende 5.

- Texture is phaneritic → **plutonic**. Quartz present, no foids → **Plutonic QAPF**.
- Enter 30 / 31 / 22. Leave the optional boxes blank — the rock is neither leucocratic enough for the anorthosite test nor in the plagioclase corner.
- Wizard returns **Monzogranite**, normalised Q 36.1 / A 37.3 / P 26.5.
- Check against Table 7.1: Q = 36.1 puts it in the 20–60 band; P′ = 100 × 22 / (31 + 22) = 41.5, which is in the 35–65 strip. Monzogranite. ✓

10.2 Example 2 — anorthosite versus gabbro

A coarse plutonic rock: plagioclase 90, quartz 2, alkali feldspar 3, mafics 5. The plagioclase is An_{62}.

- Plutonic QAPF. Enter 2 / 3 / 45 (or 2 / 3 / 90 — only the ratios matter). Normalised: Q 4.0 / A 6.0 / P 90.0, so P′ = 93.8.
- With **An = 62** and the Mafics box left blank the wizard returns **Gabbro**.
- Now enter **Mafics = 5**. The result changes to **Anorthosite**, because M < 10 overrides the gabbro/diorite name.
- Had the plagioclase been An_{40} instead, the same composition would return **Diorite**.
- And with Mafics = 93 and Olivine = 60 % of mafics, the wizard returns **Peridotite** — the rock is ultramafic and should be re-run on §7.7.

Lesson: on the plagioclase corner of the plutonic triangle the three-mineral mode alone is not enough. Fill in An % and Mafics.

10.3 Example 3 — basalt versus andesite

A dark, fine-grained, vesicular lava. Groundmass mode: plagioclase 87, alkali feldspar 10, quartz 3; total mafics (pyroxene + olivine + opaques) 45 % of the rock.

- Aphanitic and vesicular → **volcanic**. Quartz present, no foids → **Volcanic QAPF**.
- Enter 3 / 10 / 87. Normalised Q 3.0, P′ = 89.7 — Table 7.2 puts this in the Q 0–20, P′ 65–100 field, which is andesite or basalt depending on M.
- With **Mafics = 45** the wizard returns **Basalt**. With Mafics = 20 it returns **Andesite**. Leaving it blank also gives Andesite, because a blank is treated as M = 0.

> This is the single most consequential blank box in the wizard. On the volcanic QAPF diagram, always fill in Mafics — otherwise every basalt you classify will come back as an andesite.

10.4 Example 4 — a peridotite

A dark green ultramafic rock, M ≈ 98. Mode: olivine 45, orthopyroxene 30, clinopyroxene 25.

- M ≥ 90 → ultramafic. Both pyroxenes present and no hornblende → **Ultramafic Ol–Opx–Cpx**.
- Enter 45 / 30 / 25. Opx′ = 100 × 30 / (30 + 25) = 54.5.
- Table 7.7: olivine 40–90 with Opx′ between 5 and 95 → **Lherzolite**. ✓

- Had the mode been olivine 45, orthopyroxene 54, clinopyroxene 1 (Opx′ = 98.2), the result would be **Harzburgite**; with orthopyroxene 1 and clinopyroxene 54 it would be **Wehrlite**.

10.5 Example 5 — tephrite versus basanite

A dark, fine-grained, foid-bearing lava. Mode: nepheline 25, alkali feldspar 15, plagioclase 60; olivine makes up about a quarter of the mafic fraction.

- Volcanic, foids present → **Volcanic Foid (F–A–P)**.
- Enter 25 / 15 / 60. F = 25 and P′ = 80.0, which Table 7.4 places in the F 10–60, P′ 50–90 field.
- With **Olivine = 25** the wizard returns **Phonolitic Basanite**; with Olivine = 5 it returns **Phonolitic Tephrite**. The split is at 10 %.

10.6 Example 6 — a sandstone, and why the diagram matters

A medium-grained clastic rock: quartz 30, rock fragments plus matrix 31, feldspar 22.

- Sedimentary Rock Group → **Sandstones (Q–R–F)**. Enter 30 / 31 / 22.
- Normalised Q 36.1 / R 37.3 / F 26.5. Table 8.1: F is between 25 and 60 and Q is below 75 → **Greywacke**.
- These are the same three numbers as Example 1, which returned Monzogranite. The wizard has no way to know what your rock is; it only knows which diagram you chose. **Always check line 1 of the result panel.**

11. Boundary and Rounding Conventions

11.1 How the wizard resolves a point on a field line

Every field test in the wizard is written with inclusive comparisons — `≤` and `≥` rather than `<` and `>`. A composition that lands exactly on a boundary therefore satisfies the test for both adjacent fields. The wizard resolves the ambiguity with a simple rule inherited from the original code:

> **Last match wins.** Each classification routine evaluates its field tests in a fixed sequence and each successful test overwrites the name set by the previous one. A point on a boundary receives the name of whichever adjacent field is tested *later* in that sequence.

In practice this means boundaries behave predictably: a point on the Q = 5 line goes to the quartz-bearing field above it, a point on the Q = 20 line goes to the granite band above it, and a point on the P′ = 50 line in the foid triangle goes to the plagioclase-rich field to its right. Four verified examples from the plutonic QAPF routine:

Input Q / A / P	Normalised Q, P′	Adjacent fields	Wizard returns
5 / 50 / 45	Q 5.0, P′ 47.4	Monzonite (Q ≤ 5) or Quartz Monzonite (Q ≥ 5)	**Quartz Monzonite**
20 / 40 / 40	Q 20.0, P′ 50.0	Quartz Monzonite (Q ≤ 20) or Monzogranite (Q ≥ 20)	**Monzogranite**
60 / 20 / 20	Q 60.0, P′ 50.0	Monzogranite (Q ≤ 60) or Quartz Rich Granitoids (Q ≥ 60)	**Monzogranite**
0 / 50 / 50	Q 0.0, P′ 50.0	Syenite (P′ ≤ 35) / Monzonite (P′ 35–65)	**Monzonite**

The third row is worth noting: at exactly Q = 60 the wizard returns Monzogranite rather than Quartz Rich Granitoids, because the Quartz Rich Granitoids test is evaluated early in the sequence and is then overwritten. This is a corner case only — at Q = 60.1 the answer is Quartz Rich Granitoids as expected.

11.2 Effect of the last-match-wins rule

Two consequences are worth keeping in mind:

- **Modifier tests are applied last and always win.** On the plutonic QAPF diagram, the routine first sets Gabbro or Diorite from the An content, then tests M < 10 for anorthosite, then tests M ≥ 90 for the ultramafic names. Each successful test overwrites the last. So a composition with An = 62 and M = 5 returns Anorthosite, not Gabbro, and a composition with M = 95 and olivine 95 % returns Dunite regardless of An.
- **Field limits quoted in this guide are the ideal IUGS boundaries.** They tell you where the line is. If your composition lands within about 0.5 % of a line, treat the returned name as provisional — recount, or report both possibilities. That is good petrographic practice in any case: the analytical uncertainty on a 500-point count is larger than the width of the ambiguity.

12. Troubleshooting and Known Gaps

12.1 Error messages

Message	Cause and fix
Please enter all three mineral percentages (0 or greater).	One or more of the Step 2 boxes is empty, negative or not a number. Fill all three; use 0 rather than leaving a box blank for a mineral that is absent.
Mineral percentages must total more than zero.	All three boxes contain 0. Enter the actual mode.
Composition falls outside the fields defined for this diagram.	The composition is valid but no field covers it. Either you are on the wrong diagram, or you have hit one of the gaps listed in §12.2.
Please select an option, then click Next.	In question mode, *Next >* was clicked with no radio button selected. Choose an option first.

12.2 Compositions with no defined field

Five regions return "Composition falls outside the fields defined for this diagram". They are documented here so that you can recognise them rather than assume a data-entry error.

Diagram	Region with no field	What to do
Volcanic QAPF	Q 20 – 60, P′ < 10	This is the alkali feldspar rhyolite field of the published diagram. Report the rock as *Alkali Feldspar Rhyolite*.
Volcanic QAPF	Q > 60 (all P′)	The quartz-rich volcanic field. Such rocks are rare; report as *quartz-rich rhyolitoid* and confirm chemically.
Charnockites	Q > 60 (all P′)	Beyond the range of the charnockite series. Check the quartz count, or use the plutonic QAPF diagram.
Sandstones	F > 60 (necessarily with Q < 40)	A feldspar-dominated clastic rock. Consider whether it is really an arkose with a mis-assigned matrix, or a weathered granitic grus.
Sandstones	Q 85 – 95 with F ≤ 5	A narrow gap between the Quartz Wacke field (which stops at Q = 85) and the Quartz Arenite field (which starts at Q > 95). Report as *quartz arenite* or *subarkose* according to the feldspar content.

12.3 Other things to watch for

- **The result panel does not refresh itself when you edit a number.** It clears when you change the rock group or the diagram, but not when you retype a percentage. Click *Classify Rock* again after every edit.
- **A blank optional box is not the same as "unknown".** Blank Mafics is treated as M = 0 in the volcanic andesite/basalt test, blank Olivine as 0, and blank An as An ≤ 50. Each of these defaults will silently push you toward one particular name. Fill the boxes in.
- **The gabbroic diagrams separate norite, gabbronorite and gabbro by plagioclase content** rather than by the orthopyroxene : clinopyroxene ratio used in the published IUGS scheme. Confirm the pyroxene assemblage petrographically before relying on those three names.
- **The Granodiorite field does not use the An content.** A calcic plagioclase in the Q 20–60, P′ 65–90 field will still return Granodiorite; there is no "quartz monzogabbro" equivalent at that quartz content.
- **The andesite/basalt M threshold differs between the two volcanic diagrams** — 35 on Volcanic QAPF, 50 on Volcanic Foid. If you are comparing results across the two, be aware of the discrepancy.
- **On the Melilite Volcanic diagram every composition above about 90 % melilite returns Melilitite,** because the field line reaches zero at that point.

- **Nothing is saved.** The wizard has no history, no export and no print layout. Record the rock name and the normalised values in your log before moving to the next sample. The browser's Back button will not restore a previous result.
- **Number formatting follows your browser's locale.** If your system uses a comma as the decimal separator, type a full stop instead — the input boxes are HTML number fields and expect a point.

13. Glossary

An content — the mole percentage of the anorthite end member in plagioclase. An_{62} means 62 % anorthite, 38 % albite.

Arenite — a sandstone with less than about 15 % fine-grained matrix.

Colour index (M) — the total volume percentage of mafic and accessory minerals in a rock; the complement of the felsic minerals.

Cpx′, Hbl′, Ol′, Opx′ — ratio coordinates used in this guide, each expressed as 100 × (one phase) / (that phase + its partner). Defined individually in §7.

Foid — feldspathoid; nepheline, leucite, sodalite, nosean, haüyne, cancrinite, analcime and the pseudo-leucites.

Grus — the coarse, feldspar-rich residue of in-situ granite weathering.

Leucocratic — pale coloured, low colour index. **Melanocratic** — dark coloured, high colour index.

Mode — the measured volume proportions of the minerals actually present in a rock, as distinct from the *norm*, which is calculated from a chemical analysis.

P′ — the plagioclase ratio, 100 × P / (A + P). The horizontal coordinate of the QAPF and FAP triangles.

Phaneritic — grains visible to the unaided eye. **Aphanitic** — grains not visible to the unaided eye.

Point counting — the standard method of modal analysis, in which mineral identifications are recorded at the nodes of a regular grid traversed across a thin section or slab.

Pyroclastic — formed by explosive volcanic fragmentation, as opposed to *epiclastic*, formed by weathering and erosion of pre-existing rock.

QAPF — the double triangle with quartz, alkali feldspar, plagioclase and feldspathoid apices that forms the basis of IUGS modal igneous classification.

Tuffite — a mixed pyroclastic–epiclastic rock, 25–75 % pyroclastic material.

Ultramafic — colour index M ≥ 90.

Wacke — a sandstone with more than about 15 % fine-grained matrix.

14. References and Further Reading

The field boundaries implemented in Winrock Wizard derive from the following sources. Where the wizard departs from them, the departures are listed in §12.

Topic	Reference
Plutonic QAPF	Streckeisen, A. (1976) To each plutonic rock its proper name. *Earth-Science Reviews*, 12, 1–33.
Volcanic rocks, lamprophyres, carbonatites, melilitic rocks	Streckeisen, A. (1979) Classification and nomenclature of volcanic rocks, lamprophyres, carbonatites and melilitic rocks: recommendations and suggestions of the IUGS Subcommission on the Systematics of Igneous Rocks. *Geology*, 7, 331–335.
Consolidated IUGS scheme	Le Maitre, R. W. (ed.) (2002) *Igneous Rocks: A Classification and Glossary of Terms*, 2nd edn. Cambridge University Press.
Overview of the IUGS systematics	Le Bas, M. J. & Streckeisen, A. L. (1991) The IUGS systematics of igneous rocks. *Journal of the Geological Society, London*, 148, 825–833.
Pyroclastic rocks	Schmid, R. (1981) Descriptive nomenclature and classification of pyroclastic deposits and fragments. *Geology*, 9, 41–43.
Lamprophyres	Rock, N. M. S. (1991) *Lamprophyres*. Blackie, Glasgow.
Metamorphic rocks	Fettes, D. & Desmons, J. (eds) (2007) *Metamorphic Rocks: A Classification and Glossary of Terms*. Cambridge University Press.

Topic	Reference
Sandstones and wackes	Folk, R. L. (1974) *Petrology of Sedimentary Rocks*. Hemphill, Austin. Dott, R. H. (1964) Wacke, greywacke and matrix — what approach to immature sandstone classification? *Journal of Sedimentary Petrology*, 34, 625–632. Pettijohn, F. J., Potter, P. E. & Siever, R. (1987) *Sand and Sandstone*, 2nd edn. Springer.
Limestones	Folk, R. L. (1959, 1962) practical petrographic classification of limestones. Dunham, R. J. (1962) Classification of carbonate rocks according to depositional texture. *AAPG Memoir*, 1, 108–121.

Winrock Wizard · Minserv · Modal classification after Streckeisen / IUGS

This guide documents the behaviour of `WinrockWizard.html` as at 11 August 2026. All field boundaries and rock names in §7–§9 were verified directly against the wizard's classification routines.