**ES083 Rocks Assignment**

When early geologists looked at rocks and processes, they determined that some things were formed as the result of the cooling of hot liquids and related processes. These rocks were called “igneous” – literally “of fire” because the liquids were hot enough to ignite grass, shrubs and trees as they flowed down the sides of volcanoes. In a simple igneous system (e.g. within a magma chamber), one in which there is no stress affecting the crystalline contents within a liquid, crystals grow in random fashion. The crystal grains tend to interlock as well.

When cooling is slow, large crystal grains – some as large as a metre or more - can develop. Faster cooling rates are reflected in smaller crystals to the point that liquids that are cooled so fast as to be “quenched” are glassy (i.e. without crystal structure). When liquid does form crystal grains at the surface of the earth, these are generally too fine to see with the naked eye.

Igneous rocks are formed in a continuum between “slow-cooling” and “quenching.” **Intrusive**, or **plutonic** igneous rocks are those igneous rocks that finish cooling within the crust (i.e. below Earth’s surface) and have crystal grains that are clearly visible to the naked eye. **Extrusive**, or **volcanic** rocks finish cooling at, or on the earth’s surface. The smallest minerals grains are too fine to see, even though visible grains may be present.

When magma migrates, crystals may be carried in it. A change in cooling rate leads to the formation of two size modes in the resulting rock. **Porphyritic** texture is the result of this process. Porphyries (igneous rocks with porphyritic texture) can be formed in both volcanic and plutonic environments. The size of the smaller mode of grains indicates in which of these environments it occurred (i.e. the “groundmass” or mass smaller crystals surrounding the larger crystals may be phaneritic or aphanitic, depending on its last stage of cooling).

Be sure to know the terms **phaneritic**, **aphanitic and porphyritic**. These are textural terms that you will need in order to complete the assignment. They pertain to igneous rocks. Again, **Phaneritic** indicates that the smallest crystals are visible to the naked eye. **Aphanitic** indicates that the smallest crystals are visible only with the aid of a microscope or other magnification.

For composition, in ***phaneritic*** igneous rocks observe the proportion of dark-coloured mineral grains (black, dark grey, or dark green) to light-coloured mineral grains (colourless, white, greyish white or pink). If dark-coloured mineral grains greatly outnumber the light-coloured ones, the rock is said to have a **mafic** (ma = magnesium, fe = ferrum or iron) composition. If light-coloured minerals greatly outnumber the dark-coloured ones, the rock is said to have a **felsic** (fel = feldspar, si = silica) composition. If the proportion of light and dark minerals are about equal, the rock is said to have an **intermediate** composition. Determining composition in ***aphanitic*** igneous rocks is a little tricker, but basically, you can approximate this by the shade of the rock (dark, medium or light). If black or very dark grey or green, the rock is **mafic**. If white, light grey, or light pinkish grey, the rock is **felsic**. If the rocks has an in-between shade (medium grey), it is **intermediate**.

Use chart 1 as help in identifying igneous rocks.

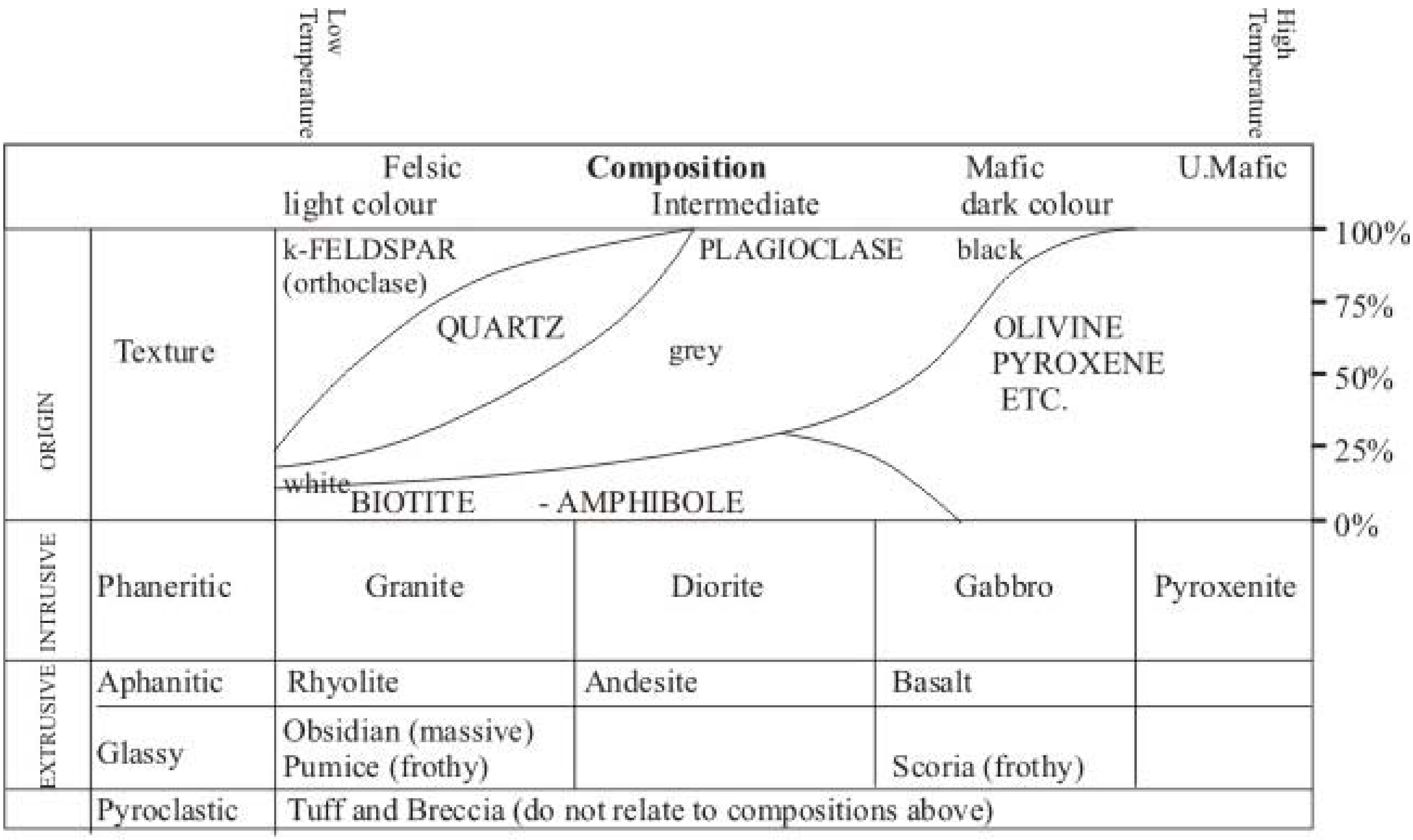



Chart 1. Classification scheme for igneous rocks.

Early geologists also realised that some rocks were formed from material that was deposited by wind, water or ice, after it had been eroded from elsewhere on the earth's surface.

Evidence of life is also contained in these rocks along with the fragments and mineral grains precipitated from solution. "Body fossils," include unaltered remains; remains that have been recrystallised, altered, replaced by foreign minerals, permineralized (impregnated by foreign minerals); moulds and casts of the original body parts. Trace fossils are traces of activity left by living things, including burrows, footprints, tracks and trails, can also be present. Sediments are deposited only at or near the earth's surface (the latter generally limited to caverns), and living things are basically limited to this realm as well.

Fragments of pre-existing rocks (themselves containing smaller pieces of rock and/or their constituent mineral grains) are grouped into size classes ranging from clay-size through silt and sand to pebbles, cobbles, boulders. The term "**clastic**" refers to sediment derived from the detritus of pre-existing rocks. The deposition of clastic material occurs when currents can no longer move the particles they transport.

In general, gravels are deposited in high-energy areas of water bodies such as the beds of fast-moving rivers and at shorelines. Sands too are deposited in rivers and near shorelines, but in slightly lower-energy areas. Obviously, sand can also be deposited by wind in dry desert areas. Silts are generally deposited on quieter waters of floodplains and water bodies. Clays tend deposited in the lowest-energy areas of water bodies, including those furthest from shore and/or in the deep areas of the sea, but can also be deposited in swamps, and the lowest-energy parts of floodplains where water movement is minimal.

**Chemical** sedimentary rocks are those rocks that are formed when water becomes so concentrated in dissolved substances that it can no longer hold this material and thus precipitates the "excess" amount. Mineral grains interpreted to have been precipitated from water include those of halite, gypsum, and occasionally calcite.

Biochemical or biogenic sedimentary rocks are composed of calcium carbonate skeletal remains of animals, usually shells or bone, or remains of plants in the case of coal. The term **"bioclastic"** is used to describe the texture of biochemical/biogenic rocks composed of fragments of material generated by life processes. A limestone whose calcite content is largely in the form of calcium carbonate shells and/or other skeletal material (collectively called bioclasts) generally indicates a warm, shallow marine environment. Coal is formed from the partially decomposed remains of plants (generally preserved as dark-coloured organic matter) that accumulate in low-energy aquatic environments such as swamps and bogs, thus is also a good indicator of depositional environment. Similarly, chert, a biogenic rock made of silica can be largely made of degraded microscopic skeletal components of organisms such as diatoms, radiolarians, and sponges can indicate a deep sea environment far away from a clastic sediment source. Note limestone reacts with acid because it is made of calcite. Coal leaves a mark on paper because it is composed of complex carbon compounds. Make sure you know the difference between "clastic" and "bioclastic."

Use chart 2 to help identify sedimentary rocks.

BIOCLASTIC AND CHEMICAL ROCK NAMES

| | |
|---|---|
| limestone  | fine to coarse calcite grains, including fossils and fossil fragments. Remember that calcite reacts with acid to form gas bubbles. In other words limestone fizzes when acid is put on it. |
| dolostone  | fine to coarse dolomite grains including fossils and fossil fragments. The fossils can appear as molds of the original fragments. Dolostone also reacts with acid, but needs to be powdered in order to exhibit the same amount of fizz. |

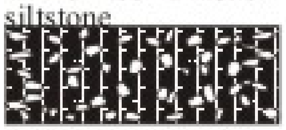
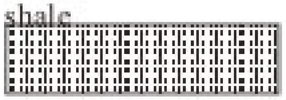
| CLASTIC ROCK NAME | SHAPE AND SIZE RANGE | CONSTITUENTS / COMMENT |
|---|---|---|
| conglomerate  | mostly rounded grains granule, pebble, cobble and boulder sized i.e. >2 mm in diameter. | typically contains lithic fragments (small fragments of older rocks), clays, other minerals, often contains quartz<br>may have a diversity of grain sizes from >2 mm to huge boulders. Rounding is due to transport from the source region. |
| breccia  | mostly angular grains granule, pebble, cobble and boulder sized i.e. >2 mm in diameter. | typically contains many lithic fragments clays, and other minerals, often often contains quartz<br>may have a diversity of grain sizes from >2 mm to huge boulders. Angularity is due to initial breakage and lack of abrasion during transport from its source. |
| sandstone  | mostly sand sized grains i.e. 1/16 mm to 2 mm in diameter | quartz, small amount of clay, orthoclase and plagioclase possible<br>has a strong grittiness to the feel. |
| siltstone  | mostly silt sized grains (i.e. 1/256 to 1/16 mm in diameter). | clay, micaceous minerals (such as muscovite), quartz likely present. Has a distinct gritty feel, but not as pronounced as with the rocks containing sand sized grains. |
| claystone/mudstone  | mostly clay sized grains (i.e. <1/256 in diameter) | mostly clay, possible calcite cement.<br>Has a smooth feel compared with siltstone. |
| shale  | mostly clay sized grains (i.e. <1/256 in diameter) | mostly clay, possible calcite cement.<br>Has a smooth feel compared with siltstone and forms thin bedded units. Its characteristic feature is that it tends to break into plate-like pieces. |

Chart 3. Chart for naming clastic sedimentary rocks.

Metamorphic rocks are formed due to applied pressure, heat, or both. Crystal growth in a stress field results in parallel alignment of the grains. The application of heat usually causes grains to become larger. Metamorphic minerals may form as a result of breakdown of earlier minerals.

Know the textural terms **foliation** and **granoblastic texture.** These are useful textural terms for metamorphic rocks. **Foliation** is used to describe the roughly parallel alignment of platy and/or elongate mineral grains. The names of some of the metamorphic rocks are married to foliation names: slate has **slaty cleavage;** phyllite has **phyllitic foliation**; schist has **schistose foliation** and gneiss has **gneissic banding**.

**Granoblastic texture** is a feature of rocks in which the mineral grains are blocky and more or less equidimensional (as opposed to platy or elongated). That is, each mineral grain is roughly the same depth as length and width. Rocks like quartzite and marble (formed from the metamorphism of quartz sandstone and limestone respectively) generally lack the platy minerals that might otherwise indicate that metamorphism involved heat and uniform pressure, or heat and differential (uneven) pressure. These rock are recognizable as having crystalline look, but having a mineral composition that is very different than most igneous rocks (e.g. calcite and “pure” quartz are rare in igneous rocks). Quartzite and marble can look very similar, but can correctly identified by an acid test or hardness. Quartzite scratches glass and doesn’t react with acid, whereas marble reacts with acid but can’t scratch glass.

For identifying metamorphic rocks that display a distinct foliation, use chart 3.

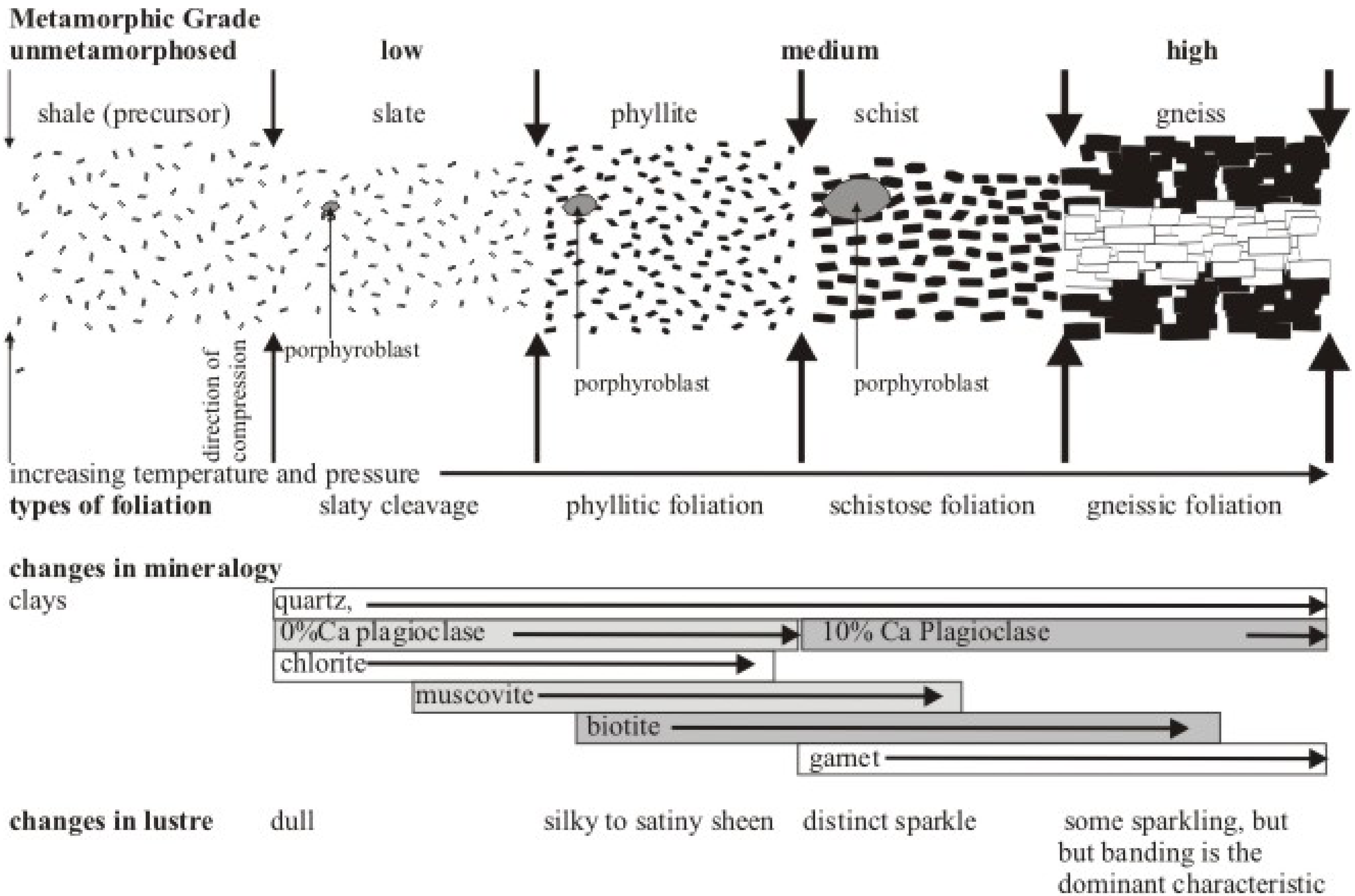



Chart 4. Development of foliation and changes in mineralogy and lustre during increasing metamorphism. Note that the arrows indicate relative amounts of compression and roughly correspond with temperature.

**ES083f Rocks Exercises** **Name** ________________________

**Student #**_____________________

Use the rocks in the middle columns of the cabinet adjacent to room 123 in Biological and Geological Sciences Building to answer the following questions.

1) What number is marked on the basalt specimen?

______________ (1)

Evidence in support of the identity:
a) texture: **aphanitic/ phaneritic /clastic / bioclastic/ granoblastic**/ **slaty/ phyllitic/ schistose/ gneissic** (circle the appropriate textural term) (1)
b) shade**: light/ intermediate/ dark** (circle the appropriate shade term) (1)

2) Where would basalt have finished its process of formation relative to Earth's surface ?

____________________________ (1)

3) What is the number marked on the granite specimen?

___________________________ (1)

Evidence in support of the identity:
a) texture: **aphanitic/ phaneritic /clastic / bioclastic/ granoblastic**/ **slaty/ phyllitic/ schistose/ gneissic** (circle the appropriate textural term) (1)
b) shade**: light/ intermediate/ dark** (circle the appropriate shade term)

4) Where would granite have finished its process of formation relative to the Earth's surface ?

_______________________ (1)

5) What is the number marked on the gabbro specimen?

____________________ (1)

Evidence in support of the identity:
a) texture: **aphanitic/ phaneritic /clastic / bioclastic/ granoblastic**/ **slaty/ phyllitic/ schistose/ gneissic** (circle the appropriate textural term) (1)
b) shade**: light/ intermediate/ dark** (circle the appropriate shade term) (1)

6) Where would gabbro have finished its process of formation relative to the Earth's surface

___________________________ (1)

7) What is the number marked on the limestone specimen?

_______________________ (1)

Evidence in support of the identity:
a) texture: **aphanitic/ phaneritic /clastic / bioclastic/ granoblastic**/ **slaty/ phyllitic/ schistose/ gneissic** (circle the appropriate textural term) (1)
b) mineral content:____________________________________________ (1)

8) In what environment would the materials that make up this limestone have been deposited?

______________________________________________________________ (1)

9) What is the number marked on the conglomerate specimen?

________________ (1)

Evidence in support of the identity:
a) texture: **aphanitic/ phaneritic /clastic / bioclastic/ granoblastic**/ **slaty/ phyllitic/ schistose/ gneissic** (circle the appropriate textural term) (1)
b) mineral content: __________________________________________________ (1)

10) In what environment would the materials that make up conglomerate have been deposited?

_________________________________________________________________________
____________________________________________________________________(1)

11) What is the number marked on the coal specimen?

_________________ (1)

Evidence in support of the identity:
a)_____________________________________________________________ (1)

12) In what environment would the materials that make up coal have been deposited ?

_________________________________________________________________________
______________________ (1)

13) What is the number marked on the shale specimen?

___________________ (1)

14) In what environment would the materials that make up shale have been deposited?

_________________________________________________________________________
____________________________________________________________________ (1)

15) What is the number marked on the schist specimen?

___________________(1)

Evidence in support of the identity:
a) texture: **aphanitic/ phaneritic /clastic / bioclastic/ granoblastic**/ **slaty/ phyllitic/ schistose/ gneissic** (circle the appropriate textural term) (1)

16) Describe the kind of conditions under which schist formed
___________________________________________________________________(1)

17) What grade of metamorphism is implied?

____________________________________(1)

18) What is the number marked on the gneiss specimen?

________________________ (1)

Evidence in support of the identity:
a) texture: **aphanitic/ phaneritic /clastic / bioclastic/ granoblastic**/ **slaty/ phyllitic/ schistose/ gneissic** (circle the appropriate textural term) (1)

19) Under what kind of conditions would gneiss have been formed relative to schist ?
_____________________________________________________________________ (1)

20) What grade of metamorphism is implied?

__________________________(1)

21) What is the number marked on the marble specimen?

___________________ (1)

Evidence in support of the identity:
a) texture: **aphanitic/ phaneritic /clastic / bioclastic/ granoblastic**/ **slaty/ phyllitic/ schistose/ gneissic** (circle the appropriate textural term) (1)

20) Fossils are primarily found in one of the three rock families. Name this rock family and explain why they would be expected to be less common to rare in the other two families.

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