GLY 4310C

LAB 8 INTRUSIVE IGNEOUS ROCKS, PART 3 (and friends)

Syenite, Phonolite, Ijolite, Carbonatite, Ultramafic Rocks and Lamprophyre

These intrusive rocks correspond to fields 6, 6', 7, 7', 11, and 15 of figure 3-1 in Hyndman. The syenites are on the border between the QAP and the APF triangles. The remaining rocks are in the APF triangle. Phonolite is actually an extrusive or hypabyssal equivalent of nepheline syenite. The ultrmafic rocks and lamprophyre are very rich in mafic minerals. Consequently they cannot be plotted on the main part of the QAPF diagram, although technically they plot in field 16 (Figure 3-1, Hyndman) in a separate rectangle. More information on these rocks is available in Chapters 9, 14, 15, 16, and 17 in Moorhouse.

SYENITE - Intrusive igneous, plutonic. The major mineral is feldspar, with greater than 65% alkali feldspar (K-spar or albite). The ferromagnesian minerals are usually ≤ 20%. The K-spar is typically orthoclase, microcline or perthite. In dikes sanidine may be present. Any plagioclase present is generally subhedral and is often zoned (normal or oscillatory). Biotite is often present and is usually brown. Small amounts of feldspathoids, like nepheline and sodalite, may be present. If more than 5% of these minerals are present, the rock is called nepheline (or sodalite) syenite. Sphene, apatite, ilmenite, magnetite, zircon, and monzonite are accessories. In the IUGS classification, 0-5 Q, and P/(A+P) is 10-35. The name is for Syene (near Aswan), Egypt. Pliny the Elder named granite-like rocks from this area for the locality.

ALKALI SYENITE - Intrusive igneous, plutonic. A syenite rich in sodium, this rock has strongly perthitic K-spars or anorthoclase, and plagioclase is albite to sodic oligoclase. The Mafic minerals include iron-rich biotite, iron or sodic amphiboles including hastingsite, arfvedsonite, or riebeckite, and pyroxene is either aegirine-augite or aegirine. There may be accessory feldspathoids.

NEPHELINE SYENITE - Intrusive igneous, plutonic. Foid syenite composed of granular aggregates, typically orthoclase, microcline, microperthite, cryptoperthite, or albite. Other felsics include nepheline and possible accessory feldspathoids such as cancrinite, sodalite, hauyne, or nosean. Mafics are soda-rich such as arfvedsonite, hastingsite, aegirine-augite, aegirine, or titanaugite.

LARVIKITE - Intrusive igneous, plutonic. Pearl gray alkali syenite, sometimes opalescent, which grades into monzonite. Typically coarse textured. Prominent crystals are rhombs of very finely twinned sodic-plagioclase and alkali feldspar. Chief mafics are diopsidic augite and titanaugite, with accessory apatite, ilmenite, titaniferous magnetite, nepheline, olivine, or biotite. Often used as a decorative stone because of a beautiful opalescence when polished. The name is for the locality, Larvik, Norway.

IJOLITE - Intrusive igneous, plutonic. A feldspathoid-rich rock, containing essential nepheline (50-70%) and pyroxene, generally aegirine. The IUGS classification is F 60-100, M 30-70, and sodium > potassium. Ijolites, carbonatites, and syenites are often associated, and are often rich in alkali elements. The silicate and carbonatite minerals have similar trace and minor element chemistries, including high values of Ba, Sr, Ce, La, Zr, P, and Cl, and are often host rocks for rare-earth and apatite minerals. The name is for the locality parish Ijo, Finland.

CARBONATITE - Intrusive igneous, hypabyssal. This is an igneous rock in which the carbonate minerals are primary. The similarity between silicate and carbonate phase trace and minor elements has convinced most petrologists that the carbonatites must originate together with the silicates, possibly from the same source, and not from limestones, as early workers had suggested. Siderite, calcite, dolomite, or ankerite are usually associated with these rocks. Other minerals that may be present include apatite, pyrochlore, Mg-rich magnetite, phlogopite, and pyrite. Apatite and pyrochlore are often considered essential.

PHONOLITE - Igneous extrusive, hypabyssal? An aphanitic rock composed of alkali feldspar, often anorthoclase or sanidine, nepheline, and mafics. Other feldspathoids may replace nepheline. The rock is usually a lava, but may occur in shallow dikes. The name is from the Gr. *phone*, meaning sound. Supposedly the rock rings when struck with a hammer. Other names are clinkstone and echodolite.

PYROXENITE - Intrusive igneous, plutonic. Pyroxenite is a rock which has ol/(ol + cpx +opx) < 40% olivine and M > 90%. A common accessory mineral in all ultramafic rocks is chromite. Magnetite is seldom seen in ultramafic rocks. Crystals may be diamond or square shaped. Crystals in hand specimen are small, seldom showing octahedral habit. In some pyroxenites, the pyroxene may contain more iron - either hypersthene or bronzite. Bronzite is so named for the noticeable bronze reflection (Schiller luster) that may be seen in hand specimen. If clinopyroxene is present it is often the variety diallage which shows well-developed parting parallel to {100} in the augite-diopside composition range. Ti-bearing augite or aegirine is also possible. Hornblende, generally brown, may be present.

BRONZITE - Intrusive igneous, plutonic. A type of pyroxenite composed almost exclusively of bronzite. Accessory minerals mat include olivine, picotite (chromian spinel), chromite, hornblende. Secondary serpentine may be present. Also called bronzite.

PERIDOTITE - Intrusive igneous, plutonic. This type contains ol/(ol + cpx +opx) > 40% and M > 90%. Dunite is olivine peridotite, with > 90% olivine. The mineralogy is similar to the pyroxenites, except that a mica, phlogopite, is often present.
The rock is feldspar free. The name is from the French name for olivine, *péridot*.

HARZBURGITE - Intrusive igneous, plutonic. Harzburgite is a type of peridotite in which the major minerals are orthopyroxene (generally near enstatite) and Mg-rich olivine. In the IUGS classification M > 90%, ol/(ol+opx+cpx) = 40-90, and cpx/(ol+opx+cpx) < 5%. Generally harzburgite is believed to represent depleted mantle material, perhaps after the removal of a basaltic component. The name is for the locality, Harzburg, Germany.

CHROMITITE - Intrusive igneous, plutonic. Igneous rock composed of 95%$^{+}$ of chromite. Similar rocks with larger percentages of ferromagnesian minerals may be named for the mineral, e.g. olivine chromitite. Rock is denser than most other ultramafic rocks.

HORNBLENDITE - Intrusive igneous, plutonic. Igneous rock with M > 90%, and hb/(hb+px+ol) > 90%.

KIMBERLITE - Intrusive igneous, dike or pipe. Kimberlite is a porphyritic peridotite or peridotite breccia that occurs as dikes or in pipes. It contains olivine, usually altered to serpentine, phlogopite (commonly chloritized), and sometimes carbonates. The groundmass is usually calcite, serpentine, chlorite, phlogopite and accessory minerals such as chromian pyrope, ilmenite, magnetite, and perovskite. Some kimberlites are diamond-bearing. The name is for the locality Kimberly, South Africa.

LAMPROPHYRE - Intrusive igneous, diaschist. Lamprophyre rocks are melanocratic or mesotype rocks hypabyssal rocks. They contain mafic phenocrysts in a fine-grained groundmass. There are many different rocks grouped under the heading lamprophyre. The usual mafic minerals are olivine (or serpentine), biotite, hornblende (usually green), and pyroxene (green diopside or Fe-Ti augite, which is purplish). The lighter-colored minerals are often alkaline, such as alkali feldspar (K-spar or albite) and Na-rich nepheline. Plagioclase is common, while quartz may be present. They are often associated with carbonatites. The name is from the Greek *lampros*, meaning bright, in allusion to the bright reflection from biotite phenocrysts found in some lamprophyres.

NEPHELINE DIORITE LAMPROPHYRE - Intrusive igneous, diaschist. A dioritic lamprophyre is one in which the major feldspar is plagioclase. In addition this rock contains the feldspathoid nepheline.

TERMS:

Cancrinite - A group of feldspathoid minerals with the general formula
$(Na, K, Ca)_{6\text{-}8}(Al, Si)_{12}O_{24}(SO_4, CO_3, Cl)_{1\text{-}2}{\cdot}n\ H_2O$.

Hauyne - A blue feldspathoid of the sodalite group with formula
$(Na, Ca)_4(Al_6Si_6O_{24})(SO_4,S)_{1\text{-}2}$. Occurs as rounded to sub-angular grains in igneous rocks. Pronounced ah-*ween*.

Lamproite - Extrusive igneous. A collective name for potassium and magnesium rich extrusive igneous rocks.

Nosean - A feldspathoid member of the sodalite group, $Na_8Al_6Si_6O_{24}(SO_4)$. May be gray, blue, or brown.

Orendite - Extrusive igneous. Porphyritic leucite lamproite, composed of phenocrysts of phologopite in a dull reddisg-gray groundmass. The groundmass consists of leucite and sanidine in approximately equal proportions. No nepheline is present. The name is for the locality, Orenda Butte, Leucite Hills, southwestern Wyoming.

Pyrochlore - $(Ca, Na)_2(Nb,Ta)_2O_6(O,OH,F)$, often contains rare earth elements. It is isometric but is often metamict as the result of alpha-particle decay from radioactive elements.

1. Examine any two of rocks number 13, 14, 17, 18, 19, 20, 21, 39, 40, 41, 42 in thin section. Prepare a labeled sketch of each selected thin section, being sure to label the sketch with magnification and either CN or PP. Identify the major minerals, and write a concise description of the petrography of the rock. This will be handed in at the beginning of the following lab.

Examine all of the rocks in hand specimen. The following rocks (numbered) from Wards North American Rock Set are particularly good type examples

13. Hornblende Syenite
14. Alkali Syenite
17. Nepheline Syenite
18. Nepheline-sodalite syenite
19. Ijolite
20. Siderite Carbonatite
21. Phonolite
39. Lamprophyre
40. Bronzite pyroxenite*
41. Dunite
42. Kimberlite

*NOTE: Ward's name for this rock, Harzburgite pyroxenite, is impossible since Harzburgite is, by definition, a type of peridotite.

In addition the following specimens are listed on the accompanying sheets.

328. Syenite (Arkansas)
329. Syenite (Colorado) NOTE: Sample has undergone alteration.
337 Harzburgite
343 Chromitite

2. **Estimate the mineral content of <u>any</u> <u>one</u> of the following specimens by identifying the minerals present and the approximate percent concentration of each. Are the names listed appropriate? This is to be turned in as a formal writeup at the next class meeting. You need to carefully examine the specimen, identify each visible mineral, and estimate its percentage. The total should be 100%. If some of the grains are too small to be identified, list the remaining percentage as aphanitic.**

Syenite, Mountain Pass, CA
Nepheline Syenite, Bancroft, Ontario #327
Leucite Phonolite, Sweetwater County, Wyoming #347
Syenite #353 (from Terry Carter)

3. **Additional samples of various rocks, illustrating many of the terms described, are also available in the lab, and should be examined.**

Harzburgite, Montana
Kimberlite, Arkansas
Kimberlite (weathered) blue ground, Arkansas
Chromitite, Twin Sisters, nr. Hamilton, Washington

4. Examine at least one interference figure from a mineral in this weeks lab. Determine the optical class and sign. If biaxial, estimate 2V. If uniaxial, determine whether the figure is centered or not. If it is not centered, approximately how far off the C axis are you viewing the figure? Prepare a labeled sketch of the figure, including the mineral name. Show the figure to the GTA. Do a different mineral each week.

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