GLY 4310C

LAB 6 **INTRUSIVE IGNEOUS ROCKS, PART 1**

**Tonalite, Diorite, Gabbro, Norite, and Anorthosite**

These intrusive (plutonic) rocks correspond to fields on diagram 2-2 of Winter. They are rich in plagioclase feldspar. More information about these rocks is included in chapters 11, 13, and 14 of Moorhouse. This is the first examination of intrusive rocks you will make. There are two outstanding differences between these rocks and those previously examined. The first is the much larger average grain size of these specimens. The grains are visible and usually identifiable. The volume percent abundance of each species becomes an important means of classification of the intrusive rocks. The second important difference is the lack of glass in these rocks as compared to the specimens from the previous two laboratories. These specimens formed at depths well below the earth's surface and therefore were slowly cooled. Since crystalline matter is in a lower energy state than glass, these rocks are totally free of glass.

**GABBRO** - Intrusive igneous, plutonic to hypabyssal. A dark-colored, phaneritic rock with medium to coarse grains. The mineralogy consists of mid to calcic plagioclase, commonly labradorite to bytownite (occasionally anorthite), and clinopyroxene, usually augite. Olivine and orthopyroxene are optional accessory minerals. In the IUGS classification gabbro contains 0-5% Q, P/(A + P) >90, pl/(pl + px + ol) is 10 - 90, and the plagioclase composition > $An_{50}$. Gabbro is the intrusive equivalent of basalt. Olivine gabbro also contains olivine in addition to plagioclase and cpx. Olivine gabbro is often richer in mafics than normal gabbro. Hornblende gabbro contains hornblende in place of the normal cpx. The plagioclase grains range from equant to lath-shaped, and are almost always well-twinned. Zoning is limited to the edge of the plagioclase grains, if present at all.

The clinopyroxene is augite or diopside. Some of these may be brown due to titanium and/or ferric iron content. Twinning is often present, but zoning is very rare. Some orthopyroxene may be present. The hornblende may be green or brown. It may occur as independent prisms or as crusts on the pyroxene.

The name may come from the gabbro region, Tuscany, Italy.

**NORITE** - Intrusive igneous, plutonic to hypabyssal. Norite is a gabbro with predominantly orthorhombic pyroxene (enstatite or hypersthene) rather than clinopyroxenes. IUGS classification is opx/(opx + cpx) > 95, 0-5% Q, P/(A + P) > 90, and pl/(pl + px + ol) is 10 - 90. The opx may sometimes be identified in hand specimen by the presence of Schiller luster. The name is for Norway, the original locality where it was first identified.

**DIORITE** - Intrusive igneous, plutonic. A phaneritic igneous rock composed of essential sodic plagioclase (oligoclase or andesine) and a mafic, usually hornblende, or more rarely, biotite or pyroxene. In the IUGS classification diorite contains 0 - 5 Q, P/(A + P) >90, and the plagioclase composition < $An_{50}$. The mafics are generally 10-40% of the rock. Quartz is present as an interstitial, anhedral component, often not visible in hand specimen. Hornblende is generally green, and may be replacing pyroxene (uralite). Biotite is very commonly found with the hornblende and is generally brown. These rocks are found in small bodies such as satellite stocks or batholiths. Diorite is the intrusive equivalent of andesite. The name is from the Greek, *diorizein*, to distinguish, because the grains are large enough to be recognized in hand specimen.

**QUARTZ DIORITE** - Intrusive igneous, plutonic. A phaneritic igneous rock composed of essential sodic plagioclase (oligoclase or andesine), > 5% quartz, and usually a mafic such as biotite or hornblende, or rarely pyroxene. In the IUGS classification quartz diorite contains 5 - 20 Q, P/(A + P) >90, and the plagioclase composition < $An_{50}$. Quartz diorite is the intrusive equivalent of quartz andesite, and corresponds to field 10* on diagram 3-1 of Hyndman.

**TONALITE** - Intrusive igneous, plutonic. Sometimes mistakenly used as synonymous with quartz diorite. The rock contains essential quartz, and plagioclase feldspar, usually andesine, with accessory mafics such as biotite, hornblende, and/or pyroxene and sometimes accessory orthoclase. In the IUGS classification tonalite contains 20 - 60 Q, and P/(A + P) >90. Tonalite corresponds to field 5 in figure 3-1 of Hyndman. If M < 10, the rock may be called Trondhjemite (after Trondhjem, Norway, the type locality). Zoning in plagioclase is common and often very strong. Zoning may be oscillatory. If K-feldspar is present it should be less than 5% of the rock. Typically it will be orthoclase or perthitic orthoclase. Quartz is almost always anhedral. Hornblende is the characteristic mafic mineral. Biotite is usually brown to brownish-green. These rocks are typically found in batholiths.

**ANORTHOSITE** - Intrusive igneous, plutonic. This rock is composed of calcic plagioclase with less than 10% ferro-magnesium minerals. The plagioclase may be labradorite, bytownite, or anorthite. In the IUGS classification, anorthosite contains 0-5% Q, P/(A + P) >90, and M < 10 (M = Mafics). The name is from anorthose, an old name for triclinic feldspars. Anorthosite is often associated with gabbro.

Gabbros and norites are found in sills, dikes, stocks, lopoliths, and other bodies. The mineralogy and texture of gabbros, norites, diabases, and basalts indicates that they are probably derived from the same type of magma crystallized under different conditions. Diabase and gabbro are often found together. Gabbroic layered intrusions may show considerable gradation in rock types between layers.

**TERMS:**

The following list of terms are associated with rocks from this laboratory assignment. You will probably be familiar with some of these terms already. You should learn any terms that you are not familiar with as they may be tested on lab quizzes or the midterm.

**Batholith** - A large, generally discordent plutonic mass that has more than 100 $km^2$ of surface exposure.

**Diallage** - A dark to grass-green, brown, gray, or bronze-colored clinopyroxene, typically augite or Al-bearing diopside, characterized by conspicuous parting parallel to the front pinacoid. Typically found in mafic rocks such as gabbro. Often occurs in lamellae or folded masses.

**Interstitial** - Minerals which fill in the spaces between larger, earlier formed grains. Generally the interstitial grains are lower in Bowens reactions series than the larger grains.

**Pinacoid** - An open crystal form consisting of two parallel crystal faces.

**Schiller luster** - An iridescence in pyroxenes due to fine exsolution lamellae usually between opx and cpx. Although the lamellae are too small to be seen, these cause an optical interference effect which appears as a metallic iridescence on crystals which are definitely non-metallic. This is one of the best methods for detecting the presence of opx in hand specimens.

**Stock** - A plutonic mass that has less than 100 $km^2$ of surface exposure. Generally discordent, it resembles a batholith except for its smaller size.

**Assignment**

**1.Examine any two of rocks number 24, 25, 28, 29, 30, 31, or 32 in thin section (<u>do not</u> examine two of the same type or rock, e.g. 28 and 30). Prepare a labelled 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. For one mineral in one of the thin sections, do an interference figure. Report the optical class, sign, and, if biaxial, the approximate value of 2V.**

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

| | |
|---|---|
| 24. Tonalite | Anonorthosite (Bytownite) Roosevelt, Oklahoma |
| 25. Diorite | |
| 28. Hornblende gabbro | Pyroxene (Diallage) Gabbro, Wichita Mts., Oklahoma |
| 29. Norite | |
| 30. Olivine gabbro | |
| 31. Hornblende gabbro | |
| 32. Anorthosite | |

**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 aphanetic.**

**Bonsall Tonalite (#7)**
**Lakeview Mountain Tonalite (#11)**
**Lakeview Mountain Tonalite (#77)**
**Quartz Diorite (#320)**
**San Marcos Gabbro Large specimen**

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