GLY 4310C
Lab 10

METAMORPHIC ROCKS, PART 2

HIGHER-GRADE REGIONAL METAMORPHICS

Gneiss and Eclogite

Gneiss and Eclogite are all regional metamorphic rock in most cases. Gneiss is a moderate to high grade regional metamorphic rock, although some augen gneiss is thought to result from dynamic metamorphic processes. Eclogite is an extremely high-grade metamorphic rock. More information about these rocks is included in Chapter 28 of Moorhouse (on the bookshelf in PS 355 - DO NOT REMOVE).

Gneiss - The gneisses are usually foliated, showing bands of felsic and mafic minerals. They can be distinguished from the schists by their lower degree of rock cleavage. Many gneisses contain streaks, lenses, or dikes of pegmatitic material. Most gneisses belong to the amphibolite or granulite facies, with the lowest facies normally being the epidote-amphibolite. They, therefore, represent an equal or higher grade of metamorphism than most schists. Retrograde metamorphism may change the typical minerals of gneisses to associations typical of greenschist facies. Gneisses are the principal rocks in very extensive metamorphic terrains.

The mineralogy of the gneisses is similar to the schists, but the proportion of flaky minerals decreases. Some pyroxene (hypersthene or diopside) is often present. The textures of the gneisses can be divided into three groups:

a) Foliated gneisses - The ordinary type with alternating bands of felsic and mafic layers. Distinct parallelism of the mafic minerals (biotite or an amphibole) is present. Biotite gneiss is a good example of this type.

b) Lit-par-lit - (French "bed by bed") gneisses, in which pegmatitic streaks alternate with normal gneissic layers. The pegmatitic material is usually granitic igneous matter, injected into the gneiss. They are also called injection gneisses or migmatites. Injection gneisses show the quartz-microcline or quartz-plagioclase layers cutting into and replacing the shreds, streaks, and bands of the older gneiss, particularly when examined in thin section. Corundum, sillimanite, or spinel may be present. These rocks are often foliated on a scale too large to be represented in hand specimen.

c) Massive or nearly massive gneisses, with only vague foliation. These are very high grade types, associated with the granulite facies. The sillimanite-garnet gneiss shows only vague foliation, while the granitoid gneiss shows none. Rocks of this type are transitional to, or part of, the granulite facies. The granulite facies is the highest grade of regional metamorphic rocks which are not formed under extreme pressure. Beyond the granulite facies rocks begin to melt and become igneous.

Parent Rocks (Protoliths) - The parent rocks of gneisses are quite varied, and the resulting products are also varied. Most gneisses form from pelitic rocks. Generally these rock form pelitic schists. As the banding becomes more prominent, the rocks grade from schist into gneiss. The mineralogy is similar to that of the schist. Common new accessory minerals include staurolite, sillimanite, kyanite, and garnet. Less common accessories include andalusite, cordierite, corundum, and spinel. Scapolite may replace plagioclase or appear as a primary mineral. Tourmaline often occurs when staurolite, sillimanite, and kyanite are present. Apatite is a ubiquitous accessory. Zircon commonly occurs in gneisses derived from arenaceous sediments. Sphene is common when the parent was a calcareous pelitic rock. Pssamitic rocks may also be the parent of a gneiss. Pure quartz sandstones produce quartzites which differ from quartzites produced under less rigorous metamorphic conditions only in texture and fabric. Argillaceous and calcareous sandstones produce gneisses that differ only in the amount of quartz present form pelitic or calcareous gneisses. Metamorphism of impure sandstones leads to the formation of gneisses under less severe conditions of metamorphism than any other parent rock. Highly siliceous rocks never form corundum or spinel during metamorphism.

Calcareous gneisses have two possible parent rocks. They may form from metamorphism of calcareous shales or sandstones, or argillaceous or arenaceous limestones. Or they may result from the injection of pegmatitic or granitic material into limestone or dolomite. Minerals characteristic of calcareous gneisses include diopside, hedenbergite, hornblende, tremolite-actinolite, sphene, plagioclase, scapolite, phlogopite, biotite, calcite, and apatite. Grossular, idocrase, periclase, wollastonite, and brucite are not found in gneisses produced by metamorphism of calcareous shales or sandstones, although they may occur in the limy bands of injection gneisses. Andalusite, kyanite, sillimanite, corundum, cordierite, and staurolite, which are typical of gneisses of pelitic origin, are absent in calcareous gneisses. Nepheline is present in some calcareous gneisses, often accompanied by alkali pyroxenes and amphiboles. Pyrrhotite is common in very calcareous gneisses.

Granulite - This name is a metamorphic facies name, but has also been used as a textural term and a lithological term meaning quartzofeldspathic metamorphics. The latter two uses are definitely not preferred. Rocks of the granulite facies may be gneissic or they may be massive. They are often garniferous, but do not contain biotite, unless it was formed by retrograde metamorphism after the main metamorphic event. The mineralogy is dominated by quartz and the feldspars. K-spars are usually strongly perthitic. Garnets are usually pyrope or grossular. Mafics include clinopyroxenes, usually diopside, orthopyroxene (hypersthene), and sometimes small amounts of hornblende. The rocks are close to granite in composition and, sometimes, in appearance. The granitoid gneiss specimen is a good example.

Eclogite - Eclogite is a high-pressure, moderate to high-temperature rock composed of garnet and green omphacite, a high-pressure Na-pyroxene. The rock is very dense (around 3.3 g/cm^3). Eclogites often undergo alteration to amphibolites. Hornblende develops from the pyroxene, and is accompanied by plagioclase. The amphibole may also be glaucophane, instead of hornblende.

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. The list also includes a number of minerals which were not commonly seen in igneous rocks.

Grunerite - A brownish mineral of the amphibole group. Formula: near $(Fe)_7Si_8O_{22}(OH)_2$ (some Mg may substitute for Fe). There is a solid solution series between grunerite and the magnesium-rich variety cummingtonite. It often occurs in metamorphic rocks as lamellae or fibers.

Piedmontite - A dark-red or reddish-brown manganese-bearing member of the epidote group: $Ca_2(Al,Mn^{3+},Fe)_3Si_3O_{12}(OH)$. Also spelled piemontite.

ASSIGNMENT:

1.Examine any two of rocks number 87, 89, 90, 91, 92, or 97 in thin section. Prepare a labeled sketch of two thin sections, 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.

87 Sillimanite-garnet gneiss
89 Augen gneiss
90 Granitoid gneiss
91 Biotite gneiss
92 Eclogite
97 Hornblende gneiss

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

100. Grunerite-Magnetite (Wards)
338. Amphibolite, San Miguel County, New Mexico
Piedmontite Gneiss, San Bernardino Mtns., California
352 Magnetite Gneiss, Valley Springs, Texas

3. 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.