GLY 4310C

LAB 11

METAMORPHIC ROCKS, PART 3

CONTACT/REGIONAL AND METASOMATIC ROCKS

Marble, Quartzite, and Serpentinite

Marble is a metamorphic rock consisting of fine to coarse-grained recrystallized calcite and/or dolomite. It is often formed by metamorphosis of limestone and may be either contact or regional metamorphic rock intermediate in grade between slate and mica schist. The surface may have a silky sheen which results from minute crystals of sericite, chlorite, etc. The calcite and dolomite crystals are very often twinned as the result of deformation. In calcite the twin planes are $(10\bar{2}1)$ and in dolomite $(02\bar{2}1)$. Differentiation of calcite and dolomite may be done in thin section on the basis of the twinning. In dolomite polysynthetic twinning appears parallel to the short and long axis of the rhombohedron, forming a rectangular grid. In calcite the twin lamellae are parallel to the long axis of the rhombohedron or are oblique to it, forming a non-rectangular grid. In hand specimen or thin section, staining of the limestone can be used to separate calcite from dolomite. There are many varieties of marble names for their accessory minerals. Examples include brucite marble, grunerite marble, pyrrhotite marble, etc.

Quartzite may be regional or contact metamorphic. It may occur as the result of metamorphism of quartz sandstones (psammitic rocks). Other quartz-rich sedimentary rocks (quartz conglomerate, chert) may also be metamorphosed. The quartz from argillaceous sandstones may be relatively undeformed by stress induced changes. In the argillaceous rocks stress is largely absorbed by the clay particles and the quartz particles may rotate without shearing. In psammitic rocks the effects of shearing and tectonic pressure elongate the quartz grains. They may show strain and generally have sutured (interlocking) contacts. Kyanite is an example of neomineraliztion, or the growth of new minerals by metamorphism. Kyanite grows only in carbonate free rocks. Although elongated it may not exactly parallel the foliation. Kyanite is a metamorphic mineral formed during the regional metamorphism of pelitic rocks. It is the moderate to high-pressure, low to moderate temperature Al_2SiO_5 polymorph and is found in moderate-grade metamorphic rocks. The presence of andalusite together with kyanite restricts the pressure to less than about 3.75 kbars.

Many varieties of quartzite exist. Some are named strictly for color, such as orange, red, brown, or black quartzite. Others are named for mineral content such as micaceous or feldspathic quartzite. Still other varieties are named for chemical content, such as aluminous quartzite.

Serpentinites were traditionally classified as igneous rocks. It has long been recognized that the serpentine in these rocks is a replacement mineral. Indeed the serpentine in unsheared serpentinites often is a classic example of pseudomorphism, retaining all the external characteristics of the olivine it replaced. In recent years it has become increasing obvious that this rock is the result of metasomatic alteration, and should therefore be classified as a metamorphic rock. *Metasomatism* may be defined as the replacement of one mineral by another due to the introduction of material to the rock, almost always from a chemically active fluid. It is usually assumed that the replacement takes place without increase in volume, although this is not easily proved. Removal of material is thus necessary and this is accomplished by the same fluids.

The fluids that cause metasomatism may come from a number of sources:

1. Ground water at depth
2. Connate water trapped in marine sediments and volcanics
3. Water from crystallizing magmas
4. Pegmatitic (siliceous) solutions generated as the late stage of crystallizing magmas
5. Pegmatitic solutions generated by anatexis (partial melting) of crustal rocks
6. Water from the metamorphic recrystallization of sediments and hydrous rocks

Serpentinite consists almost wholly of one or more serpentine minerals, which include antigorite, chrysotile, and lizardite. It may also include calcite, magnesite, dolomite, talc, chromite, magnetite, and other minerals. the color is usually green to greenish-black, although yellow and even reddish varieties are known. Luster varies from dull to waxy. They may be homogeneous or banded, streaked, or spotted. Polished serpentinite is often called serpentine marble.

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.

Brucite - A white, gray, or light green mineral which commonly occurs as thin, pearly folia or in fibrous habit. Formula: $Mg(OH)_2$. Often found in serpentine and metamorphosed impure limestone or dolomitic limestone.

Cordierite - A light to dark blue mineral found as an accessory in some granites, and as a common constituent of many low-pressure metamorphic rocks. The cordierite-amphibolite facies represents the lower pressure part of the amphibolite facies. Formula: $(Mg,Fe)_2Al_4Si_5O_{18}$. Cordierite is commonly found in contact or regionally metamorphosed argillaceous rocks, and in hornfels produced by contact metamorphism of pelitic rocks.

Crystalline Limestone - A metamorphosed limestone, or a marble formed by recrystallization of limestone. The term is also used to indicate a sedimentary rock with formed of abundant calcite crystals produced by diagenesis.

Opaline - Often used to mean a brecciated, impure opal pseudomorphous after serpentine. It may also mean a rock with a groundmass or matrix consisting of opal.

Predazzite - A brucite marble in which brucite is usually pseudomorphous after periclase. Calcite content exceeds brucite. Forsterite may be present. The name is for the locality, Predazzo, Italy.

Silicated Marble - A rock in which the process of silication has occurred. Silication is the conversion into or replacement by silicates. This process is common in the formation of skarn minerals in carbonate rocks.

Skarn - Lime-bearing silicates, of any age, derived from nearly pure limestone and dolomite by the introduction of large amounts of Si, Al, Mg, and Fe, usually by metasomatic solutions.

ASSIGNMENT:

1. Examine two of the rocks numbered 72, 73, 76, 85, or 86 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.
You should do one sketch of a marble, and one of a quartzite.

43 Serpentinite
72 Pink Marble
73 Dolomite Marble
76 Quartzite
85 Staurolite Quartzite
86 Kyanite Quartzite

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:

Quartz-rich dolomite - Riverside, California
Wollastonite
Crystalline Dolomite - East side Owens Lake, Inyo Valley, California
Silicated Marble - Lucerne Valley, California
Opaline magnesite - North of Baker, California
Predazzite-brucite marble - Crestmore, California
Crystalline Limestone - Crestmore, California
Predazzite Marble - Riverside, California

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.

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