Learn to identify the minerals common in metamorphic rocks formed at high-pressure/low-temperature metamorphic conditions (i.e., subduction zone complexes like the Franciscan Complex). All but two of these rocks are metamorphosed mafic rocks.

**Amphibolite facies**

Excluding water, this rock has the approximate composition of basalt or andesite. However, most of them contain abundant hydrous minerals not found in mafic igneous rocks.

**#66. Epidote amphibolite with relict plagioclase phenocrysts;** western Sierra Foothills, Calif.

The rock is unfoliated; the relict phenocrysts are conspicuous. The metamorphic grade is transitional with amphibolite facies.

Relict phenocrysts of plagioclase: albite twinning; partly altered to saussurite: (clino-?)zoisite and sericite. Why has this saussuritization generally been most intense near the centers of the phenocrysts?

The groundmass has completely recrystallized to:

Sodic plagioclase — 50
Quartz — 5: in veinlets and pods
Hornblende — 40
Epidote-group minerals — 5: based on refractive indices and anomalous interference colors, there appear to be two epidote-group minerals in this rock — zoisite and clinozoisite?
Garnet or spinel in plagioclase (as alteration product?): very fine-grained
Sphene — trace

**Blueschist facies**

**#97. Weakly foliated Franciscan metagraywacke:** Panoche Pass, California. Relict sand-sized grains of quartz and chert are recognizable in hand specimen and in thin section. In thin section it should be clear that this is a thoroughly recrystallized (metamorphic) rock.

Sericite: Abundant
Chlorite: Minor
Glaucophane: Rare with characteristic blue color
Sphene/leucoxene: Minor
Lawsonite: Abundant — Colorless, tabular, medium birefringence, parallel extinction. Tends to occur as single crystals, in contrast to the aggregates of jadeite
Opal (?): has weak birefringence and forms cross-cutting veinlets in a few slides (e.g., slide b)
Rutile: large patches of very fine grains (slide 97e only)

Note the absence of feldspar in this rock. Because this is a metagraywacke, there must once have been feldspar in it. Why is there none now?
#98. **Metachert**, Franciscan complex, Laytonville quarry, California. What other name might be assigned to this rock?

Quartz
Spessartine: the garnet is spessartine because this chert, like most, is rich in manganese
Stilpnomelane: resembles biotite, but there is no biotite in this rock or in any rock metamorphosed in the blueschist facies.

Why is this rock very unlikely to be a quartzite (i.e., a metamorphosed quartz arenite)?

#99. **Glaucophane schist**: Franciscan formation, Cazadero area, California. The composition of this rock is approximately basaltic, but the abundance of muscovite indicates contamination (metasomatism during retrograde metamorphism). The protolith might be basalt, gabbro or eclogite.

Glaucophane
Actinolite — there is epitaxial growth of glaucophane around actinolite
Muscovite
Garnet
Chlorite
Sphene
Rutile — rare
Epidote group mineral
Hematite

**Eclogite facies**

#100. **Eclogite**: Tiburon, California. The following primary minerals belong to the eclogite facies:

Eclogite-facies minerals:

Omphacite — 55: Pale green color
Garnet — 20
Rutile — 2

The following minerals probably formed during upward transport (retrograde metamorphism) of the eclogite:

Muscovite — 5
Chlorite — 5-10
Sphene — 2
Clinozoisite — trace
Glaucophane — trace in some slides
Lawsonite — trace in some slides