

Excerpt from
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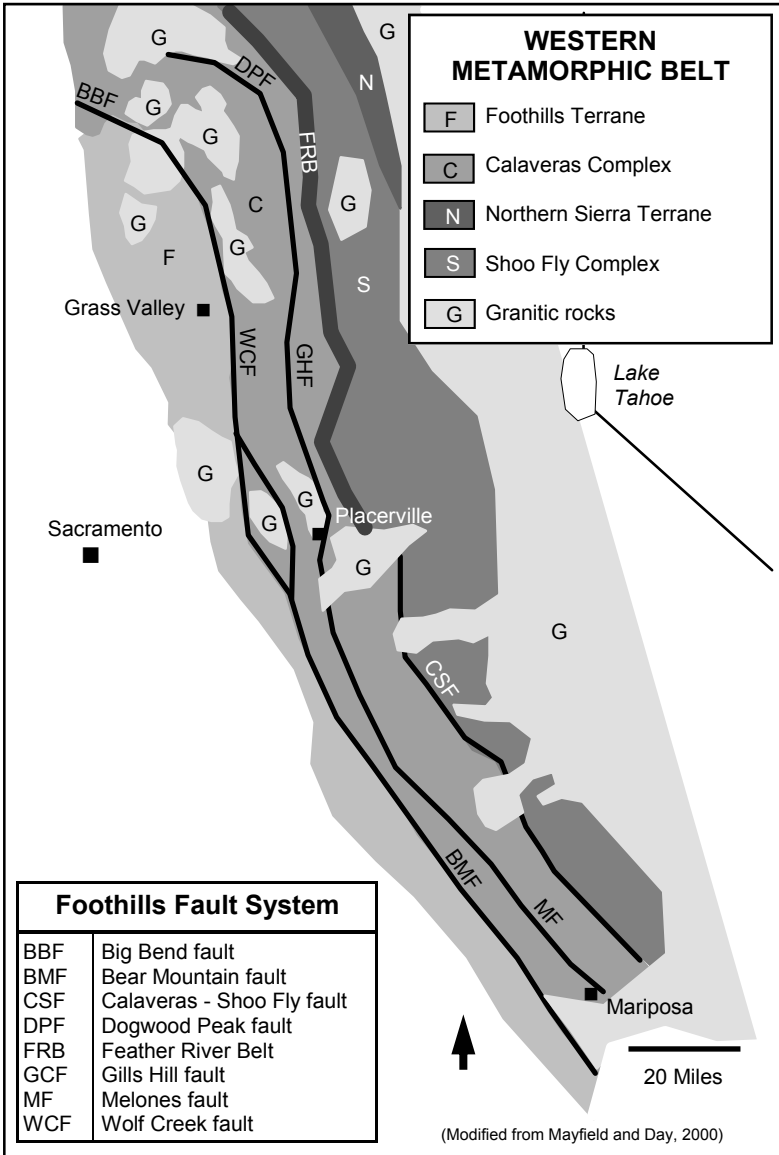
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WESTERN METAMORPHIC BELT

The Western Metamorphic Belt is a broad band of metamorphic rocks that lie on the west side of the Sierra Nevada batholith and extend northwest for 200 miles through the foothills of the central and northern Sierra. The south end of the belt, near Mariposa, is about 30 miles wide and the belt thickens northward to about 60 miles in the northern Sierra. The belt is divided into three major rock units that also trend northwest. The Shoo Fly Complex lies on the eastern side of the belt, the Calaveras Complex forms the center, and the Foothills Terrane is on the western side. Each of these rock units is bounded and separated from the other units by large faults. Some of these faults extend the entire length of the metamorphic belt. The rocks within each unit are also cut by numerous faults. Collectively, these faults are known as the *Foothills fault system*.

The rocks of the Western Metamorphic Belt were deposited during Paleozoic to Jurassic time in a series of subduction zones that existed along what was then the western margin of North America. The subduction activity ended in late Jurassic time when all of the rocks of the metamorphic belt were subjected to a brief but intense period of deformation and metamorphism, referred to as the Nevadan orogeny. During this orogeny, the rocks in the metamorphic belt were squeezed, faulted, folded, metamorphosed, and added to the western margin of North America. After these rocks were added to the continent, the new margin of North America was along the western border of the Great Valley, and the new Franciscan subduction zone formed in what is now the Coast Ranges of California.

There are many different types of rocks in the metamorphic belt, including schist, slate, phyllite, greenstone, serpentine, chert, marble, and quartzite. These rocks have been faulted, folded, metamorphosed, and intruded by granite and other igneous rocks. Thus, the rocks of the Western Metamorphic Belt are extremely complex, and unraveling the geologic secrets of the metamorphic belt has been a long and difficult task for geologists. Nonetheless, based on the work of these geologists, a general picture has emerged of how the rocks in the metamorphic belt



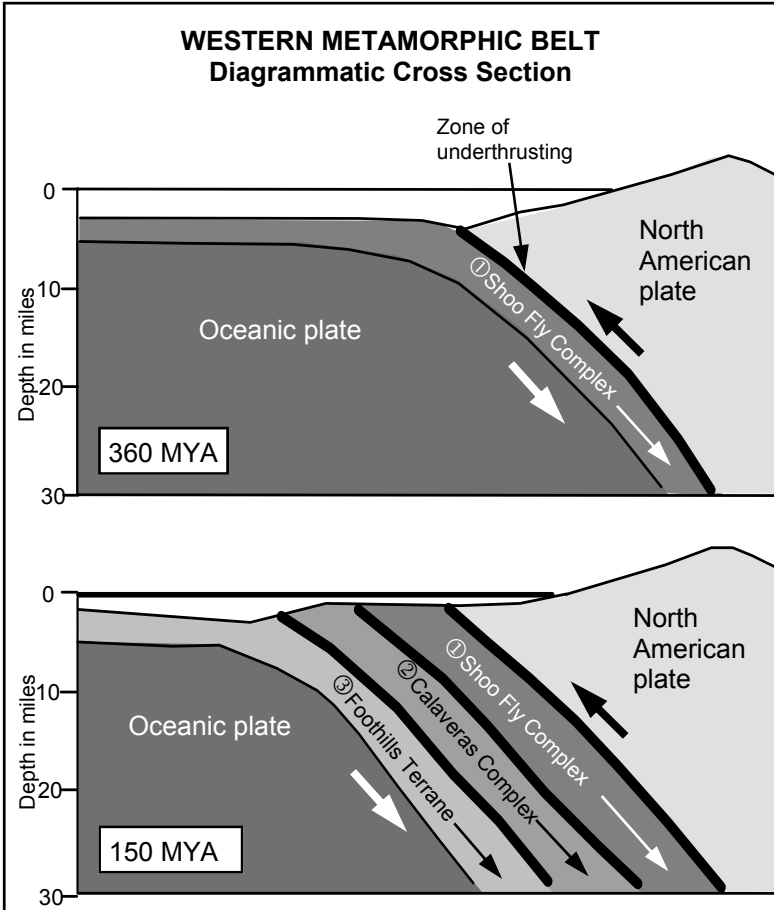
were formed. Needless to say, this picture is subject to change as more information is squeezed from the rocks in the continuing work on the metamorphic belt.

The rocks and faults of the Western Metamorphic Belt all dip steeply to the east. This east dip can be seen almost everywhere that the rocks are exposed. In this stack of east-dipping metamorphic rocks, the oldest rocks, the Shoo Fly Complex, lie to the east, and are on the top of the stack. The youngest rocks, the Foothills Terrane, are on the west side of the belt and on the bottom of the stack. This is the opposite of what we normally see in sedimentary rocks. In layered sedimentary rocks, the oldest rocks are on the bottom of the stack and the youngest rocks on top. The reversal of the rocks in the Western Metamorphic Belt occurred as a result of subduction. When each new rock unit was carried into the subduction zone, it was inserted under the rocks that were already in the subduction zone. The east-dipping rocks thus piled up like pancakes on an east-tilted platter. However, on this platter, the newest pancakes were inserted under the pancakes that were already on the platter. To get a fresh pancake from this platter, you would need to take it from the bottom of the stack.

Within the Western Metamorphic Belt there are a number of plutons of granitic and mafic rocks that have been intruded into the metamorphic rocks. Some of these plutons are outliers of the Sierra Nevada batholith and others represent magma chambers for the volcanic arcs that formed at various times along the continental margin. There are also many fault slices of serpentine and other ultramafic rocks within the Western Metamorphic Belt. These ultramafic rocks represent pieces of oceanic crust that were torn off in the subduction zone. Serpentine also occurs along many of the faults of the Foothills fault system. This serpentine represents pieces of oceanic crust that were squeezed into and along the fault zones during the subduction process.

Shoo Fly Complex

The rocks of the Shoo Fly Complex are the oldest rocks in the metamorphic belt. They consist mainly of metamorphosed sedimentary rocks that were derived from the North American plate and deposited on the oceanic crust to the west. In mid-Devonian time, these rocks were subjected to a major period of subduction and mountain building known as the Antler orogeny. The Antler orogeny was brief and intense. During this period, the rocks of the Shoo Fly Complex were compressed, metamorphosed, cut by numerous thrust faults, intruded by igneous rocks, uplifted, and eroded.



In this model of the Western Metamorphic Belt, the Shoo Fly Complex ① went into the subduction zone first, followed by the Calaveras Complex ② and the Foothills Terrane ③. During Cretaceous time, the rocks in the subduction zone were uplifted and eroded. Rocks that had been buried at depths of 30 miles or more were eventually exposed at the surface.

In the northern Sierra, the rocks of the Shoo Fly Complex are covered by several thousand feet of volcanic and volcanoclastic rocks known as the Northern Sierra Terrane. These rocks were derived from a series of island arcs that formed along the margin of the North American plate during late Devonian to Mesozoic time. The Sierra Buttes near Sierra City are formed from these rocks, and the rocks are also well exposed at Big Bear Lake, north of Sierra City.

Calaveras Complex

In mid-Devonian time, after the Antler orogeny, the margin of the North American plate was immediately west of the Shoo Fly Complex and a subduction zone was present west of the continental margin. The rocks of the Calaveras Complex accumulated in this subduction zone. These rocks are mainly black and green slate, schist, and greenstone. The greenstone was formed from basalt and other volcanic rocks that had erupted at spreading centers. The slate and schist represent sediments that were deposited in deep ocean trenches. Other rocks of many types were brought into the subduction zone from the west by plate movement. Many of these rocks were mixed together by faulting and folding in the subduction zone and now form a tectonic mixture of limestone, chert, basalt, and pieces of oceanic crust. The lubricant for this *melange* is mainly the clay that was deposited on the ocean floor. In early Mesozoic time, the rocks of the Calaveras Complex were added to the western margin of North America, and the stage was set for deposition of the Foothills Terrane.

Foothills Terrane

In late Triassic time, the Nevadan subduction zone formed to the west of the Calaveras Complex. The rocks of the Foothills Terrane accumulated in this subduction zone until the beginning of the Nevadan orogeny in late Jurassic time. The Foothills Terrane is mainly phyllite, slate, and greenstone. This rock unit also contains the well-known Mariposa Slate, which consists of platy black slate and serves as the host rock for many of the gold deposits of the Mother Lode. Another important rock unit, the Smartville Complex, occurs in the northern part of the Foothills Terrane. The Smartville Complex consists of a large slab of oceanic crust that was carried into the Nevadan subduction zone and thrust on top of the rocks that were already in the subduction zone. It is unusual to find exposures of oceanic crust such as this in continental areas.

Foothills Fault System

The Foothills fault system includes a number of major northwest-trending faults that cut through the rocks of the Western Metamorphic Belt. Several of these faults extend for tens of miles, and some extend for the entire length of the metamorphic belt. These faults separate the rocks of the Western Metamorphic Belt into many discrete fault-bounded units. Following is a brief description of some of the most important faults.

The Calaveras-Shoo Fly fault is the easternmost of the major faults and separates the Calaveras Complex from the Shoo Fly Complex. In the northern Sierra, the Calaveras-Shoo Fly fault bifurcates and becomes a

thick zone of complexly faulted rocks referred to as the Feather River Belt. The Feather River Belt contains many ultramafic rocks. These rocks represent the remains of a large ocean basin that was carried into the subduction zone and squeezed between the Shoo Fly Complex and the Calaveras Complex.

The Melones fault cuts through the rocks of the Calaveras Complex. The fault dips steeply eastward and is marked by intensely sheared rocks, quartz veins, and lenses of serpentine. The shattered rocks along this fault are also impregnated with many different minerals, including gold, copper, zinc, and lead. The large gold deposits along the Mother Lode closely follow this fault from Placerville to Mariposa. Although the Melones fault is well-defined in the southern and central parts of the metamorphic belt, the fault splays to the north, and there is some uncertainty concerning its counterpart in the northern Sierra.

The Bear Mountain fault is the westernmost of the major faults. Along this fault, the rocks of the Foothills Terrane were thrust eastward under the rocks of the Calaveras Complex. In the northern Sierra, this fault is known as the Wolf Creek fault. The gold deposits in the Grass Valley area occur in fractured rocks near this fault.



The serpentine in this roadcut near Goodyears Bar is green, smooth, and has a waxy luster. The grooves on the surface of the serpentine were formed during movement of the serpentine in the subduction zone.