

GEOLOGIC COLUMN AND UNIT DESCRIPTIONS

AGE	ROCK UNIT	LITHOLOGY; THICKNESS WHERE KNOWN	UNIT DESCRIPTION
QUATERNARY	Alluvium	Sand, gravel, and clay. Thickness less than 5 meters.	Alluvium composed of gravel, sand, and clay; occurs everywhere along rivers.
	Pleistocene basalt	Olivine basalt.	Sheets and flows of greenish black olivine basalt; occurs in the small areas east of Ying-pan [* 2] and north of Tung-hua [2 2].
TERTIARY	Tertiary formation	Sandstone, shale, oil shale, coal, and dolerite (b). Thickness 500 to 700 m.	The Tertiary sedimentary rocks constitute the Shih-men-shai [5 7 2] coal field which extends about 15 km long and about 2 km wide. The lower part consists of black shale, coal, sandstone, and green shale, intercalated with flows of dolerite (b); the upper part consists chiefly of brown shale (oil shale). Two coal seams, varying in total thickness from 1 m to 1.7 m, are known. Plant fossils indicate the age of Oligocene.
	Quartz porphyry	Dikes of quartz porphyry intruded into Ordovician limestone.	Quartz porphyry; occurs as dikes. The rock intrudes the Ordovician limestone northeast of Ku-lung-yu-shu [2 2 2] and is light gray and compact containing a small amount of quartz phenocrysts.
MESOZOIC	Diorite	Dark to pale green diorite.	Dark to pale green diorite consists of plagioclase and hornblende with some augite, orthoclase, and quartz. Near Ku-chia-tzu [2 2 2] it intrudes Cretaceous sedimentaries, and near Erh-peng-tien-tzu [2 2 2] it intrudes Cretaceous volcanics.
	Granite	Granite and monzonite.	Coarse-grained, light or grayish red granite is generally porphyritic, and is often monzonitic or monzonite. The granite mass in the southeastern part of the map area is intruded into Jurassic coal-bearing beds and Cretaceous volcanics. In contact with Cambrian, Ordovician, and Carboniferous limestones, the granite forms copper-iron deposits.
	Cretaceous volcanics	Andesite, rhyolite, tuff, and agglomerate.	The Cretaceous volcanics, dark reddish brown or dark greenish gray, consist chiefly of andesite, rhyolite, tuff, and agglomerate; widely distributed covering granite gneiss and Cretaceous sedimentaries.
	Cretaceous	Tuff, sandstone, shale, and conglomerate. Thickness 500 to 1000 m.	The Jura-Cretaceous sedimentary rocks (M) are locally subdivided into Cretaceous sedimentaries (M ₁), Upper Jurassic beds (M ₂), Middle Jurassic beds (M ₃), and Lower Jurassic beds (M ₄). The Cretaceous sedimentaries consist of thick beds of reddish tuff, reddish or greenish sandstone, sandy shale, and conglomerate, with some agglomerate. Usually exposed in a narrow zone in the depressed areas along rivers. Usually poor in fossils. A dark gray sandstone south of Man-tzu [2 2 2] differs somewhat from the sandstone of other localities in that reddish rocks are more scarce and fossil of gastropods and pelecypods are abundant but poorly preserved.
	Upper Jurassic	Conglomerate and sandstone. Thickness more than 100 m.	The Upper Jurassic conglomerate consists mainly of gravels of quartzite and other siliceous rocks. Probably unconformable to the Middle Jurassic.
	Middle Jurassic	Sandstone, shale, coal, and conglomerate. Thickness 300 m.	The upper part of the Middle Jurassic beds contains about 10 coal seams which vary from 0.6 to 1.8 m in thickness, and constitutes the Tien-shih-fu [2 2 2] coal field around Tsu-pu [2 2 2]; the lower part mainly consists of conglomerate, and unconformably overlies the Lower Jurassic beds. Many fossil plants have been reported from both the upper and the lower parts.
	Lower Jurassic	Shale, sandstone, and limestone. Thickness 50 m.	The Lower Jurassic beds are mostly black shale, intercalated with thin layers of sandstone and marly limestone. The age of this series at Tien-shih-fu has been differently assigned by different geologists to Lower Jurassic, Triassic, or Permian.
	Permian	Sandstone, shale, aluminous shale, and coal. Thickness 650 to 750 m.	The Permian formation includes the upper and middle parts of the Taitzho [2 2 2] system. The upper part is composed chiefly of red, green, and yellowish-gray sandstone and shale. An aluminous shale occurs at the base of the upper part, although some geologists consider it as the uppermost unit of the middle part. The middle part of the Taitzho system consists mainly of alternating beds of black shale and gray sandstone, and contains 2 or 3 workable coal seams. Thin beds of limestone occur at the base. Leptodendron, Anularia, Sphenophylax and other fossil plants were reported from the Tien-shih-fu coal field. Permian formation is unconformable to the lower part of the Taitzho system which belongs to the Carboniferous.
	Carboniferous	Shale, aluminous shale, sandstone, and limestone. Thickness 100 to 200 m.	The Carboniferous formation (lower Taitzho system) is characterized by an alternation of varicolored shale and sandstone, and contains lenticular limestone, aluminous shale, and cony shale or thin coal beds. Abundant fossils from the lenticular limestone indicate the age as Middle Carboniferous.
	PALEOZOIC	Ordovician formation	Limestone, dolomite, and marl. Thickness 400 to 600 m.
Cambrian formation		Shale, sandy shale, and limestone. Thickness 500 to 600 m.	The Cambrian formation is divided into three parts. The upper part consists chiefly of black, bedded limestone (including vermicular limestone) in association with thin beds of marl and shale; fossils include <i>Illanurus</i> and <i>Limulicella</i> . The middle part is composed of alternating beds of limestone, shale, and marl, characterized by several layers of oolitic limestone in several horizons; fossils include <i>Obolus</i> and <i>Bailella</i> . The lower part consists mainly of red shale, accompanied by green micaceous sandstone and lenticular limestone; fossils include <i>Redlichia</i> and <i>Girvanella</i> .
Sinian system		Quartzite, shale, and siliceous slate. Thickness 300 to 700 m.	The Upper Precambrian formation in the map area is known by the name of Hsiao [2 2 2] series which belongs to the Sinian system. It is extensively distributed in the regions along the Tai-tzu Ho and Tsou-tzu [2 2 2], and is less metamorphosed than the Middle Precambrian Liaocho system. The formation is divided into three parts, from lower to upper; Tsou-tzu [2 2 2] quartzite, Nanfen [2 2 2] shale which includes red and green marly shale, and the Chiantou [2 2 2] quartzite which includes siliceous slate. Sun cracks and ripple marks are common on the bedding plane of the quartzites.
PRECAMBRIAN	Granite gneiss	Granite gneiss and migmatite gneiss.	The oldest granite gneiss is grayish white, medium- or fine-grained and characteristically tonalitic quartz diorite, with a schistosity always parallel with that of the Middle Precambrian formation (p _{2m}). Locally it grades into gray migmatite gneiss which includes crystalline dolomite. These gneisses are often intruded by another Precambrian granite gneiss which is characterized by a reddish color, less schistosity, and a predominance of microcline.
	Liaocho system	Phyllite and schist. Thickness 1000 to 1,500 m. Crystalline dolomite and schist. Thickness more than 2,000 m.	Distribution of the Middle Precambrian formation (Liaocho system) in the map area is rather limited, although the rocks belonging to the formation occur in many places as xenoliths captured by the granite gneiss (ggn) and often altered to migmatite. The upper beds (p _{2m}) consist of phyllite and schist. The lower beds (p _{2d}) are composed of crystalline dolomite and crystalline schists of various degrees of metamorphism.
	Undifferentiated Precambrian beds	Quartzite, slate, and dolomite. Thickness more than 5,000 m.	Undifferentiated Precambrian rocks occur north of Shih-men-shai and extend out of the map area. The rocks, unconformably resting on the granite gneiss (ggn), are mostly quartzite and dolomite. A cycle of sedimentation, which begins with quartzite and ends in dolomite, repeatedly appears in the rocks. In lithology and geologic sequence the rocks resemble the Hsiao series and may represent a facies of the Sinian system, but in predominance of dolomite they are closer to the Liaocho system.
AGE UNKNOWN	Granite	Biotite granite and hornblende granite. (Column not drawn to scale)	The biotite granite in the southeastern part of the map area is intruded into the granite gneiss (ggn) and is covered by the Cretaceous volcanics (Cv). Locally it shows schistosity and contains large phenocrysts (about 3 cm long) of orthoclase. Another biotite granite occurring along the west border of the map grades into the granite gneiss of indistinct schistosity, and is intruded into the Sinian system of the adjacent map area (refer to She-yang sheet, W 51-0). A granite of unknown age in the northern part of the map area is a hornblende granite, consisting of quartz, orthoclase, plagioclase, and hornblende, with a minor amount of biotite.

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