

Late Jurassic and Late Cretaceous Metamorphism  
in the Uppermost Unit of the Cretan Nappe System

SEIDEL, EBERHARD, MARTIN OKRUSCH, MANFRED SCHLIESTEDT,  
Technische Universität Braunschweig, Mineralogisch-Petrograph.  
Institut, Postfach 3329, D-3300 Braunschweig,  
HANS KREUZER, WILHELM HARRE and HELMUT RASCHKA,  
Bundesanstalt für Geowissenschaften und Rohstoffe,  
Postfach 51 0153, D-3000 Hannover 51, F.R. Germany

**Abstract:** High-grade/low-to-medium pressure rocks of the uppermost nappe of Crete were formed during a Late Cretaceous (70 m.y.) regional metamorphism as established by concordant K/Ar ages of hornblendes and biotites. Rocks formed under elevated pressure and medium temperature yielded amphibole and phengite ages of about 145 m.y., indicating a Late Jurassic metamorphism.

**Résumé:** Une série variée de roches métamorphiques de haut degré (700°C, 5 kb près de Lentas, dans le Monts d'Asterousia) est un constituant typiques de la nappe ophiolitique de la Crète. K/Ar âges concordants des hornblendes et des biotites de 70 Ma de toutes les occurrences principales de la nappe, prouve un refroidissement rapide au Maastrichtien.

Les roches à métamorphisme de moyenne température et de pression élevée (500-550°C, 6-8 kb) de Crète et de Gavdos ont donné des âges des amphiboles et des phengites d'environ 145 Ma et prouve donc un métamorphisme au Jurassique supérieur.

Ces résultats renforcent la corrélation de la nappe avec la zone pelagienne/subpelagienne de la Grèce continentale.

In the island of Crete we distinguish at least five pre-Neogene geological units. The uppermost nappe can be divided into an upper part of serpentinite bodies, and a heterogeneous basal part containing high-grade rocks as the most typical constituents. No pronounced zonation of critical minerals was recognized. Locally small bodies of synkinematic granites are intercalated with the high-grade rocks.

At Léntas (Asteroússia) amphibolites are characterized by the assemblage brown hornblende - diopside - plagioclase (An 50) while associated metapelitic gneisses consist of garnet - cordierite - biotite - sillimanite (andalusite) (-K-feldspar) - plagioclase (An 40-50) - quartz. From relevant experimental data including the Fe/Mg distribution on coexisting garnet and cordierite, the p-T conditions are estimated to 5 kb and 700°C. Three hornblendes from these rocks yielded a mean K/Ar age of  $71.2 \pm 1.0$  m.y., two biotites  $69.9 \pm 0.9$  m.y. and a third biotite  $67.9 \pm 1.4$  m.y.. Similar, nearly concordant K/Ar ages for hornblendes and biotites from all major occurrences of the nappe prove a quick cooling in Early Mastrichtian and thus an Eo-Alpidic high-grade regional metamorphism.

Metamorphic rocks formed by medium temperature and elevated pressure are known from Central Crete and from the small island of Gavdos. They also belong to the uppermost tectonic unit. Temperatures of 500-550°C are estimated from the occurrence of almandine, the coexistence of hematite and ilmenite, and by the reaction dolomite + quartz + actinolite + calcite. Elevated pressures (6-8 kb) are indicated by the high content of phengite in the white mica, by garnet appearing earlier than biotite, and by the widespread occurrence of glaucophane, crossite, and barroisite. Seven of eight phengites and one hornblende yielded nearly concordant K/Ar ages between 142 and 147 m.y., indicating that these rocks underwent metamorphism during Late Jurassic. One hornblende yielded a lower model age (132 m.y.) than the coexisting phengite, whereas three hornblendes gave higher dates (156, 166, 191 m.y.) without clear tendency in isochron plot. So far no confident explanation of the amphibole dates can be given. The uppermost tectonic unit of Crete is a composite nappe. It comprises rock complexes differing in type and age of metamorphism and can be related to the Pelagonian/Sub-Pelagonian zone of the Greek mainland.