



Bulletin of the Mineral Research and Exploration

<http://bulletin.mta.gov.tr>



THE TECTONO-STRATIGRAPHIC FEATURES OF METAMORPHITES IN ALACAHAN-ÇETİNKAYA REGION (KANGAL, SIVAS)

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ABSTRACT

Key words:
Tectono-stratigraphy,
Bolkardağı Nappe,
Karaböğürtlen
Formation, Taurus
Mountains, Kangal

The study area covers Alacahan, Çetinkaya and Kangal regions. Allochthonous and autochthonous rock units are present in the region. Metamorphic rocks exposed in the region have been studied in detail as formation and member and have been incorporated into the Bolkardağ Nappe. Bolkardağ nappe which deposited in Late Devonian-Late Cretaceous and metamorphosed in green schist facies, has been distinguished into Late Devonian Düzce formation, Carboniferous Kınalar formation, late Permian Çayderesi formation, (?)Middle/Late Triassic-Cretaceous Kayaköy formation and Cretaceous Karaböğürtlen formation from base to top. The quartzites found at the base of the Kınalar formation and metaconglomerates at the base of the Karaböğürtlen formation has been defined as 'Bakırtepe Member' and 'meta-conglomerate Member' respectively. Bolkardağ Nappe internally has numbers of imbricated structures. Yeşiltaşyayla complex consisting of blocks and slices of Gülbahar nappe, Güneş ophiolite and Munzur nappe overlies the Bolkardağ nappe with a tectonic contact. On the other hand Hekimhan formation, Kangal formation, Yamadağ group volcanics, Göbekören basalts and Plio-Quaternary cover units overlie the Bolkardağ nappe with an angular unconformity.

1. Introduction

Study area is in the Kangal, Çetinkaya, Alacahan region, in Sivas in the North Eastern part of the Eastern Taurus (Figure 1). Kurtman (1973), Bayhan (1980), Bayhan and Baysal (1982), Tunç et al (1991), Gürer (1992, 1994), İnan et al (1993), Gültekin (1993), Sayar and Gültekin (1993, 1995), Yılmaz (1994), Öztürk et al (1996), Yalçın and Bozkaya (1997), Yılmaz et al (2001) and Yılmaz and Yılmaz (2004) carried out general geological studies in various parts of the study area.

Gültekin (1993) carried out a study in the Alacahan-Çetinkaya-Divriği area and appointed Middle-Late Devonian-early Carboniferous age to the metamorphic units and considered them as Kangal Formation. Gültekin (1993) indicate that Late Jurassic-Early Cretaceous Kıratgediği re-crystallized limestones overlie the Kangal formation with an angular unconformity and ophiolites emplaced

during Middle-Late Campanian and Saya formation were deposited during middle-late Campanian-early-middle Maastrichtian.

Gürer (1994) studied the stratigraphy of the Hekimhan-Hasançelebi area, evolution of Hekimhan basin and its position within the regional geology. Gürer (1994) stated that Hocalıkova ophiolite which is believed to have been transported from the north to the south in late Campanian, forms the bedrock of the area. Hekimhan basin opened up following the ophiolite emplacement. Karadere formation is composed of fluvial, deltaic and shallow-marine sediments deposited during late Campanian-early Maastrichtian and unconformably overlie ophiolites. Gürer (1994) indicated also that late Campanian-late Maastrichtian Hekimhan formation which is transitional with the units of the Karadere formation was deposited in tectonic controlled transgressive marine environments.

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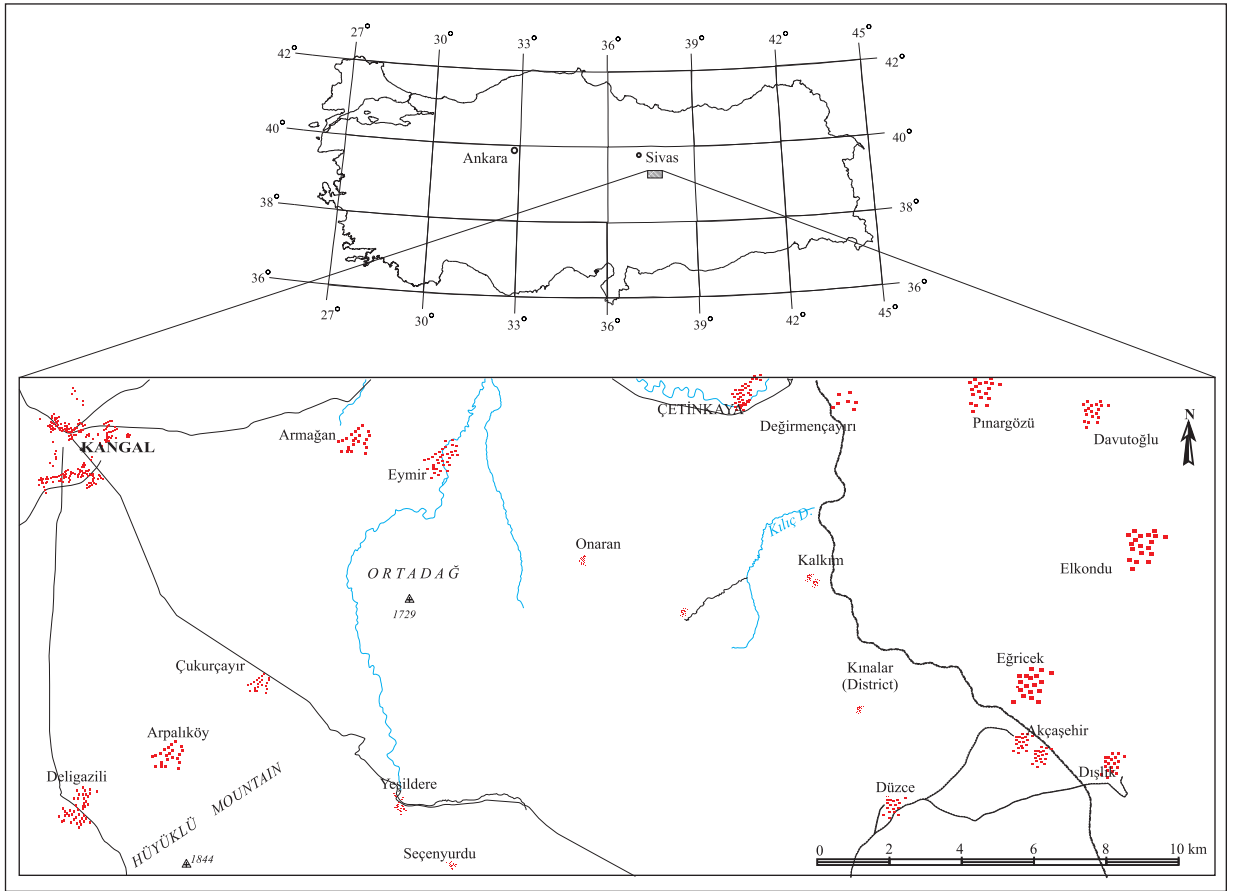


Figure 1-Location map of the study area

Yalçın and Bozkaya (1997) studied the burial and thrust mechanism relations of the Late Palaeozoic metamorphic rocks in the area. They determined that detritic parts of the Middle Devonian-early Carboniferous Kangal formation from base to the top have different lithological, textural and mineralogical characteristics as a result of burial and thrusting.

In this study tectono-stratigraphic features of the metamorphic rocks in the region have been studied.

2. Regional Geology

The study area is located in the Eastern Part of the Taurus Belt which started developing during the Alpine orogeny. Along the Taurus Belt there are numbers of units such as 'Geyikdağı Unit', 'Aladağ Unit', 'Bolkardağ Unit' and 'Bozkır Unit' represented by different stratigraphic, structural and metamorphic environmental conditions but also have tectonic relations with each other (Özgül 1976). Plate movements and oceanic crust development in the Eastern Taurus quite likely started in Late Jurassic-Early Cretaceous (Titanian-Berriacian) (Tarhan

1982). The ophiolites in the area are considered to be belong to the Southern branch of the Neo-Tethys and some parts have inner Taurus Oceanic origin (Şengör and Yılmaz 1981). In the area, oceanic crust started to develop and continued its development until Late Cretaceous as a result of rifting between Taurid-Anatolid platform and Bitlis-Pütürge massifs (Şengör and Yılmaz 1981). At the beginning of Late Cretaceous (Cenomanian-Turonian) the compressional regime started to develop in the crust (Yazgan 1981, 1983).

Özgül (1976) conducted a detailed study of the Taurus belt and indicated that the Taurus belt consisted of 6 units. Among these units Geyikdağı Unit is autochthonous; Aladağ, Bozkır, Antalya and Alanya Units are allochthonous.

The detailed descriptions of Geyikdağı, Aladağ and Bolkardağı units were defined by Özgül (1976) in the Central Taurus. He reported that Aladağ and Bolkardağı units consist of shelf type carbonate and detritic rocks deposited in Late Devonian-Late Cretaceous and flysch with Senonian olistoliths.

In the eastern part of the Eastern Taurus Belt, Alan et al. (2007) defined 5 structural units quite different from each other. Bolkardağ Unit is one of those structural units. In this structural unit they identified Carboniferous Aykuşdere formation, early Permian Erenlersirtı formation, late Permian Dumlutepe formation, Early-Middle Triassic Bastırık formation, Middle-Late Triassic Tozlutepe formation, Late Triassic Metrisyayla formation, Jurassic-Cretaceous Koçakaletepe formation and Late Cretaceous Kaledere formation.

Bedi et al. (2009) carried out geological study in the western part of the Eastern Taurus Belt. They defined allochthonous rock units of different ages and representing different environments, tectonic relations with each other and autochthonous rock units. Tectono-stratigraphically from the base to the top it includes; Late Cretaceous Dağlıca complex, Late Jurassic-Cretaceous Kömürhan ophiolites and Bodrum nappe. Campanian-Maastrichtien Baskil granitoids intrude into the Kömürhan ophiolites and Bodrum Nappe. In the Binboğa mountain, units of the Lycian Nappe cover large areas in the south as well as in the north. These rock units display different stratigraphic and structural characters. From the base to the top are Gülbahar Nappe, Köseyahya Nappe and Munzur Nappe (Bedi et al. 2009).

From the base to the top the Bodrum Nappe consists of Late Devonian-Carboniferous Yoncayolu Formation, Late Permian Çayderesi formation, Early Triassic Alıçlı formation, (?) Middle-Late Triassic-Late Cretaceous Kayaköy formation, Ula formation with recrystallized limestones and intercalated dolomitic limestones. From Dogger onwards Kaya formation has horizontal and vertical transitions with Ula Formation. Late Cretaceous Karaböğürtlen formation with meta flysch comes to the top as a cover for the metamorphic units (Bedi et al 2009).

In the study area all of the geological features appear to have acquired their position in the area bound with the Taurid platform, Arabian platform, Northern branch of Neo-Tethys in the North and Southern branch of Neo-Tethys in the South.

During geodynamic evolution of the area some important geological events and related structural and stratigraphic features developed. These features are considered to have developed in three stages such as; pre-Maastrichtian stage, Maastrichtien stage, and Miocene-present stage. In the pre-Maastrichtien stage, it appears two basins were present, one in the north of Gürün Görelı autochthon, the other one in the

south. Here northern and southern Ophiolites which were bound by the Gürün para-autochthone started plunging northwards under the Taurid and Anatolid platforms during pre-Maastrichtien (late Santonian-Campanian) stage. This development initiated the closing of the inner Taurid Ocean and northern branch of Neo-Tethys. Closing of the oceanic crust initiated large scale nappe developments. The successions of the Bolkardağ Nappe, particularly near to the Oceanic crust side of the platform (in accretionary prisms) and in the parts where crustal thickening were highly effective, were subjected to burial metamorphism. In the parts where burial mechanism was not effective (not much affected by the nappe developments) platform deposits and ophiolites of the Munzur and Gülbahar Nappes have not been affected by metamorphism (Bedi et al 2009).

The braided-river, deltaic and shallow-marine sediments of the Davutoğlu Member of the Hekimhan Formation deposited as a result of uplifts of the region and related sea-level fall in Maastrichtian (Beyazpınır et al 2010).

In late Campanian-early Maastrichtian as a result of slowing down of subduction in the Southern ocean and subduction movement changed into transform fault and North-South compressional tectonic regime was replaced by extensional tectonic regime (Gürer 1992). Volcanisms have accompanied to sedimentation of Davutoğlu Member which is consisting of continental-shallow marine sediments at the base of the Hekimhan formation.

Nappe movements were quite effective until Maastrichtian and oceanic crust started closing and nappes in the thinning areas (Güneş ophiolite, Yeşiltayşayla complex, Munzur nappe, Gülbahar nappe, Bolkardağı nappe) started acquiring their present day positions. In Maastrichtian in the opened up basins Hekimhan Formation has developed (Gürer 1992, 1994).

In the period between Miocene-present; along with shallow water, continental sedimentations have developed. Collisions and/or post collision volcanisms and deep faults related to volcanisms have also become effective (Beyazpınır et al 2010).

3. Stratigraphy

Autochthonous and allochthonous units are present in the study area (Figure 2).

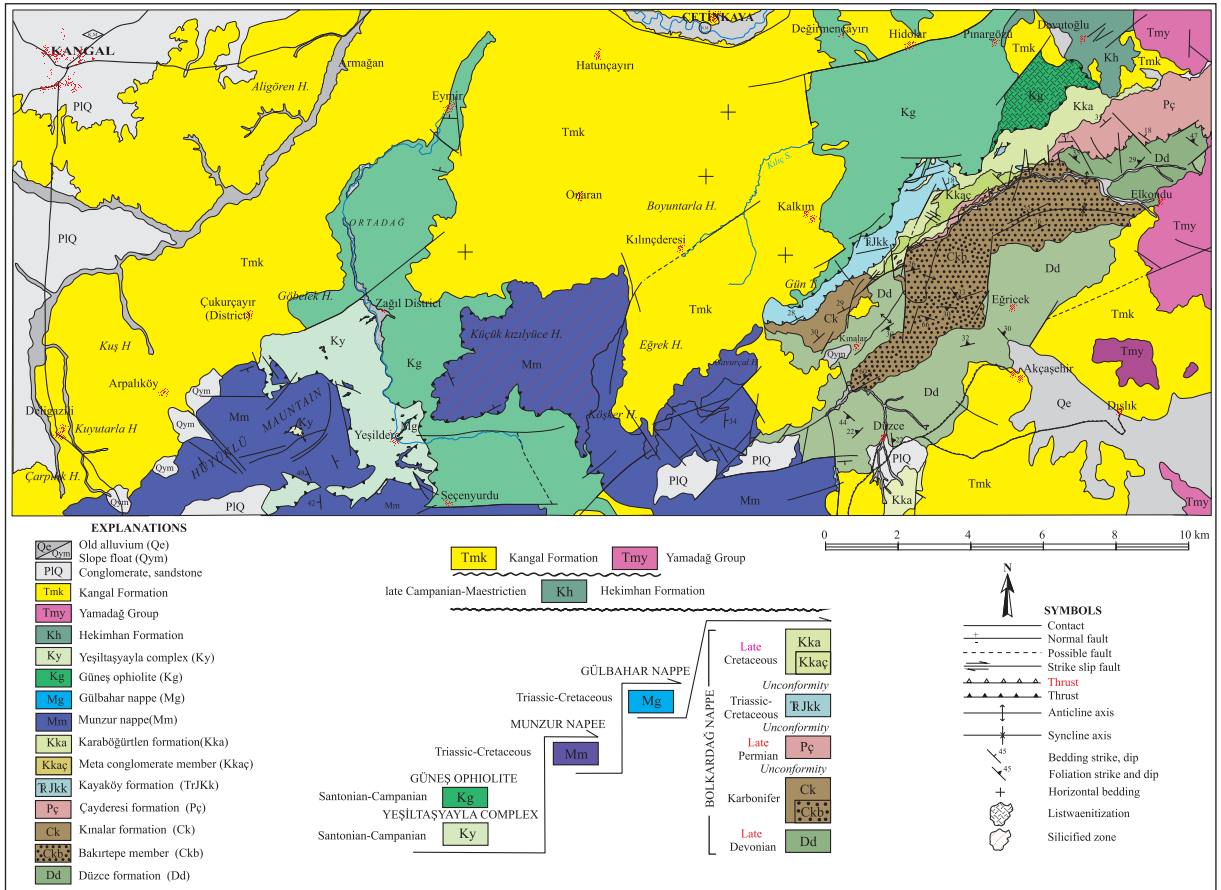


Figure 2- Geological map of the study area .

Bolkardağı Nappe (Özgül, 1976; Beyazpirinç et al 2010), Munzur Nappe (Bedi et al 2004, 2009) Yeşiltaşayla Complex (Erkan et al 1978) and Gülbahar Nappe are present in the Yeşiltaşayla Complex (Poisson 1977; Bedi et al 2004, 2009; Şenel et al, 1989) and Güneş Ophiolite (Bayhan, 1980) are allocthonous units emplaced in the area as nappes in pre Late Maestrichtian. Bolkardağ Nappe form the bedrock of the study area. Munzur Nappe and Yeşiltaşayla Complex which also includes Gülbahar Nappe and Güneş ophiolite have been found with tectonic contacts on the top of Bolkardağ Nappe from bottom to top. Yeşiltaşayla Complex includes tectonic blocks and slices of Gülbahar nappe and Munzur Nappe. Autochthones units overlie the older units with angular unconformity. They are; Hekimhan formation (Gürer, 1992, 1994), Kanganal formation (Aktimur et al., 1988), Yamadağ group volcanics (Beyazpirinç et al., 2010), Göbekören basalts (Atabey, 1993) and Plio-Quaternary units (Figure 3).

Metamorphic rocks present in the study area have been defined as Bolkardağ Nappe. In this work tectono-stratigraphic features of the Bolkardağ Nappe have been studied.

3.1. Bolkardağ Nappe

Metamorphic rocks in the study area have been studied at member level in detail. They were previously named as Kanganal formation (Gültekin 1993, Yalçın and Bozkaya 1997) and Alacahan Group (Öztürk et al 1996). Similar studies carried out for the metamorphic rocks at similar facieses in the Taurus belt have been named as Keban metamorfites (Perinçek, 1979a, b), Kabaktepe and Cağilhan metamorfites (Tarhan, 1982, 1984), Keban and Malatya Nappes (Yazgan, 1983), Malatya metamorfites (Perinçek and Kozlu, 1984a, b; Yıldırım, 1989; Yiğitbaş, 1989), Engizek group (Baydar, 1989), Keban-Malatya unit (Yılmaz et al 1992), Bodrum nappe (Bedi et al, 2009). Metamorphic rocks in the area are quite similar to the Bolkardağ group studied by Özgül (1976, 1997) in Central Taurus. Units of the Bolkardağ group which deposited during Late Devonian-Late Cretaceous interval consist of shelf type carbonates and detritic rocks which have undergone low grade metamorphism.

In this study, unit defined as Bolkardağ Nappe mainly consists of schist intercalated with marble,

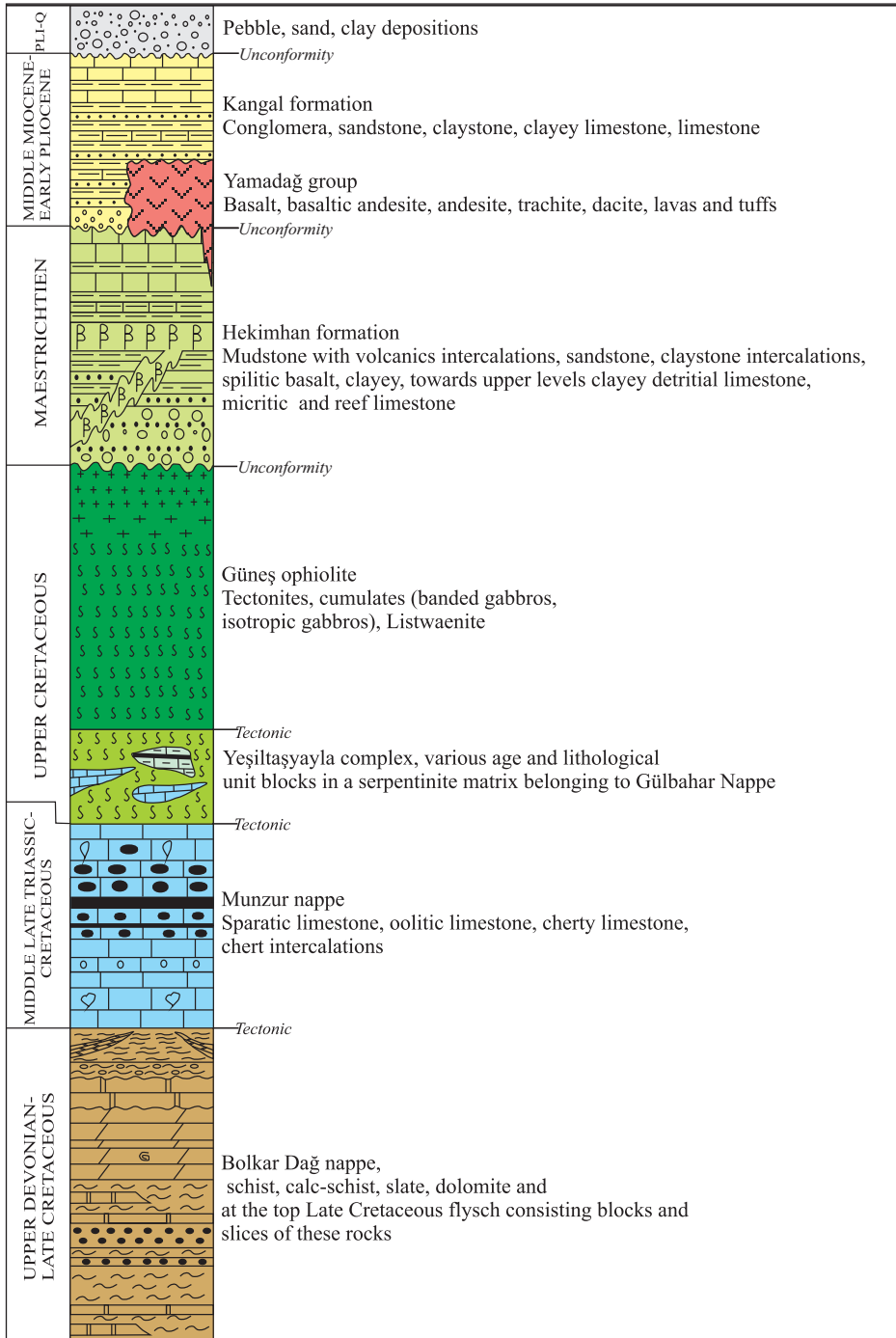


Figure 3- Generalized tectono-stratigraphic columnar section of the study area.

calc-schist, slate, re-crystallized limestone, quartzite and marble lithofacies.

Bolkardağ Nappe was deposited during Late Devonian - Late Cretaceous interval and has been subjected to green schist type metamorphism. From the base to the top it consists of late Devonian Düzce formation (Dd), Carboniferous Kınalar formation (Ck), Late Permian Çayderesi formation (Pç), (?)

Middle-late Triassic-Cretaceous Kayaköy formation (TrJKk) and Late Cretaceous Karaböğürtlen formation (Kka) (Figure 4). Quartzites at the base of the Kınalar formation have been defined as ‘Bakırtepe Member’; Meta conglomerates at the base of the Karaböğürtlen formation have been defined as ‘Meta conglomerate Member’. Early Triassic level of the Bolkardağ Nappe has not been observed in the study area.

Tectono-stratigraphic Characteristics of Alacahan-Çetinkaya Metamorphites

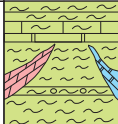
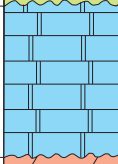

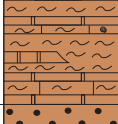
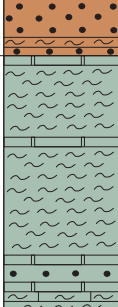
UPPER SYSTEM		SYSTEM	SERIE	LEVEL	FORMATION	MEMBER	THICKNESS (m)	ROCK TYPE	ROCK TYPE CHARACTERISTICS	FOSSILS
M E S O Z O I C		CRETACEOUS	UPPER		Karaböğürten formation (Kka)	Meta-conglomerate Member (Kkae)	150		Meta-conglomerate; marble, calc-schist, meta-siltstone, schist and various age blocks and slices	
								Meta-conglomerate; blackish gray variegated coloured, medium-thick with regular beddings		
P A L E O Z O I C		TRIASSIC	UPPER		Kayaköy formation (Trkka)		200		Marble, dolomite; white, whitish coloured thick- very thick beddings, massive, in places with cherts	<i>Aulotortus sinousus</i> , <i>Wenyschenk</i> , <i>Aulotortus?</i> <i>Gaschei</i> (Koehn-Zaninetti & Brönniman), <i>Aulotortus</i> sp., <i>Trochommina</i> sp., <i>Ophthalmidium</i> sp., <i>Alg</i>
								Unconformity		
P A L E O Z O I C		PERMIAN	UPPER	Murgabian-Midian	Çayderesi formation (Pc)		300		Dolomite with thin bituminous shale and marble intercalations; blackish gray, black, brownish black coloured, medium-thick-very thick regular beddings, in places lens like with cherts	<i>Pseudovempirella</i> sp., <i>Mizzia</i> sp., <i>Neoschwagerina</i> sp., <i>Gastropod</i> , <i>Crinoids</i>
								Unconformity		
P A L E O Z O I C		CARBONIFEROUS			Kınalar formation (Ck)	Bakırçepe Member (Ckb)	340		Quartzite, marble, dolomite, schist, calc-schist lens and marble intercalations. gray, blackish gray, reddish coloured medium-thick-very thick regular beddings	Fusulin, Crinoids, Gastropod and Coral
							425	Meta-sandstone; brownish red coloured, thick-very thick in places medium foliation		
DEVONIAN		UPPER			Düzce formation (Dd)		450		Marble, quartzite, sericite quartzschist, mica-schist, calc-schist, quartz mica-schist, chlorite-quartz-mica sericite-schist; in general yellow, reddish brown, very thin-thin foliations at the lower sections, in places marble intercalations, in places clayey and sparatic texture and with quartzite intercalations	<i>Aulacella</i> sp., <i>Rhynchonellid</i> <i>and Crytospiriferid</i> <i>forms of Brachiopod</i> <i>shell fragments and numerous crinoids</i>

Figure 4- Generalized columnar section of the Bolkardağ Nappe.

3.2. Düzce Formation (Dd)

In the Kınalar formation ‘Düzce re-crytallized limestone Member’ of Gültekin (1993) is the same as the ‘Hocalar formation’ described by Özgül (1997). In this study this unit is re-named as the ‘Düzce formation’. It forms the base of the Bolkardağ Nappe and consists of meta -sandstones with calc-schist-marble intercalations, schist, slate.

The unit displays reference quality type sections in the North of Düzce village (Suluyurt Dere), also in Kınalar Village and on the southern slopes of the

Kıratgediği Tepe. It consists of quartzites; sericite quartzites; chlorite, quartz mica-schist; slate; mica quartzs-chist, mica-schist,, quartz mica-schist, calc-schist.

At the top it has meta-sandstones and schist-slate intercalations. The unit is thinly foliated and has yellow, brownish red colour. In the lower sections it has locally intercalated with marble.

Weathered marbles are yellowish gray, pinkish coloured; fresh broken surfaces in places are rough, yellow, beige, coffee, reddish coloured. In places it

displays, medium-thick scale good beddings. It has in places sparitic textures, has quartzite intercalations. It has knotted and flow structures, rich in fossils (Crinoids, Corals, Brachiopods). Weathered sandy-clayey calc-schists display yellowish gray colour, fresh fracture surfaces have yellow colour, in places have sericite smearings, and have thin-medium scale good beddings. 20-30 cm thick calc-schist intercalations in parts are rich in fossils (Crinoids, Brachiopods and shell fragments).

The measurable thickness of the Düzce formation is 450 m (At Kıratgediği Tepe)

Paleontological studies conducted on the samples collected from the Düzce formation showed the presence of Brachiopod shell fragments *Aulacella* sp., Rhynchonellid and Cyrtospiriferid forms (determined by Dr. Gonca Nalcioğlu). The presence of rich Crinoid's fossils shows that Düzce formation is likely to be at Late Devonian age. Sayar and Gültekin (1993) appointed Middle Devonian-Late Devonian age by the paleontological studies. All these data indicate that Düzce formation is possibly at Late Devonian age.

Düzce formation resulted from the green-schist facieses metamorphism of detrital and pelitic rocks in shallow water-slope environments.

3.3. Kınalar Formation (Ck)

Gültekin (1993) described this unit as Kınalar Member of the Kangal formation. In this study it is considered as formation and has been described as such.

The unit crops out in the area between North of Kınalar Village (Southern slopes of Cinalibaşı Tepe), Mollaosmançalı Tepe, Karadağ Tepe and Bakır Tepe. It mainly consists of quartzite, marble, dolomite, schist and calc-schist. Weathered surfaces of the marbles have gray colour, the freshly fracture surface is blackish gray, reddish colour, has good, medium-thick-very thick beddings. They have karstic cavities, are fractured, have calcite filled veins and has sparitic texture.

Marbles are in the form of lenses and interlayers and in places has cherty nodular, dolomitic character. They contain fossils (Fusulina, Crinoids, Gastropods and Corals). Quartzite's at the base of the succession have been named as Bakırtepe Member and described accordingly.

Measured thickness of the Kınalar formation in the upper part is 340 m. When the thickness of the Bakırtepe Member in the Cinalbaşı Tepe is included it amounts to 765 m. Continuation of the unit has not been observed, laterally it exhibits variations, in places it has carbonate lenses and layers.

Kangal formation can partly be correlated with the Kınalar formation but Özgül (1997) could not find any fossil data to appoint an age to the Kınalar formation. On the other hand fossils as such Fusulina, Crinoid and Corals found on the fresh rock faces of the marbles and calcschists indicate Early Carboniferous age (Sayar and Gültekin 1993). Stratigraphic position and correlations with the units of similar facies in the Taurids range, Carboniferous age fits reasonably well to the Kınalar formation.

Kınalar formation is represented by the metamorphic rocks of the sandstones, limestones and mudstones. It is suggested that these lithologies deposited in a shallow-marine and slope environment according to the rock types and metamorphosed in a green schist facies.

3.3.1. Bakırtepe Member (Ckb)

Quartzite and meta-sandstones in the study area were defined by Gültekin (1993) as 'Bakırtepe metaquartzite Member' of the Kangal formation. In this study quartzites and meta-sandstones have been considered in the Kınalar formation and re named as 'Bakırtepe Member'.

Bakırtepe unit consists mainly of quartzites with lesser amount of meta-sandstones. Reference quality type sections can be seen in Bakır Tepe. Weathered surface of the quartzites have blackish, reddish brown colour, fresh fracture surfaces are reddish brown, lead gray colours. They have lineated textures, are massive, and thickly foliated, small-medium in places with large crystals, heavily iron oxide stained and in places with quartz discharge.

In Bakır Tepe, 'Bakır Tepe Member' has 425 m known thickness. It does not display lateral continuations and it is at lens form at the bottom of the Kınalar formation.

'Bakır Tepe member' does not have any fossils. But as it is concordant with the Düzce Formation at the top and is situated at the bottom of the Carboniferous Kınalar formation, based on the stratigraphic position and its correlations with the similar unit facies in Taurids, Carboniferous is the assumed age for the 'Bakırtepe Member'.

In general quartzites are the main rock type. The origin of the quartzites is considered to be quartz rich sandstones deposited in shore-beach environment.

3.4. Çayderesi Formation (Pç)

Özgül et al (1981) carried out geological studies in the Keban-Malatya area and named the limestone unit as 'Çayderesi Limestone'. Yılmaz et al (1992) used the 'Çayderesi formation' name. In the study area the unit for the first time defined and 'Çayderesi formation' name has been adopted.

Çayderesi formation extends from Saraydüzü, Kulluk Tepe, Northern slopes of Kıratgediği Tepe, Naldöken Tepe to southern slopes of Naldöken Tepe and Çal Tepe in the area.

Main rock type of the 'formation' is dolomite; towards the top of the succession it includes thin bituminous shale intercalations. It is generally blackish gray, black and ash coloured, massive, medium-thick and sometimes displays regular beddings. Bituminous shale's have thin-medium beddings. It has calcite fillings, fractured-cracked, folded, in places with chert nodules and has fossils (Gastropod, Algae, Crinoids, *Mizzia*, *Hemigordius*).

The thickness of the 'Çayderesi formation' has been measured to be 200 m in the Kıratgediği Tepe. Rock types show lateral variations and have gastropod and crinoid pieces, *Mizzia* and *Hemigordius* fossils in various parts.

Paleontological studies carried out on the collected samples identified the presence of *Mizzia* sp., *Pseudovemporella* sp., *Neoschwagerina* sp fossils, indicating Late Permian (Murgabian-Midian) age.

Dolomitized carbonates of 'the formation' indicate reasonably quite shallow marine environments.

3.5. Kayaköy Formation (TrJKk)

This unit was first identified in Munzur Mountains and named as 'Kale Tepesi Limestone' by Özgül (1981). It was then named as 'Kayaköy formation' by Bedi (2009). In this study 'Kayaköy formation' name is used.

Rock units of the 'Kayaköy formation' crop out on the southern slope of Cinalıbaşı Tepe, on Saylak Tepe, Naldökenin Çal Tepe and in the Hanife Öreni area. It is also found as 25-30 m thick tectonic slices in the Karaböğürtlen formation in Naldöken Tepe region. Güneş Ophiolite overlies 'Kayaköy formation' with a tectonic contact.

The unit is generally represented by re-crystallized platform type carbonates. Rock types are marble and dolomite with cherts in the upper levels. Gray, blackish, in places cream, white coloured, with massive, thick-very thick beddings, fine crystals, fractured, karstic voids, calcite veins, upper levels with chert nodules. Marbels have mostly been dolomitized. Samples collected from the lower level of the Kayaköy formation have *Aulotortus sinousus* Wenynschenk, *Aulotortus? gaschei* (Koehn-Zaninetti & Brönnimann), *Aulotortus* sp., *Trochammina* sp., *Ophthalmidium* sp., Alg fossils indicating Late Triassic age. Bedi et al (2004, 2009) determined (?) Middle-Late Triassic-Late Cretaceous age to the 'Kayaköy Formation'.

'Kayaköy formation' consists of platform type carbonates. Data indicates that from Middle-Late Triassic age; onwards the units were deposited in a reasonably quite, shallow marine environment.

3.6. Karaböğürtlen Formation (Kka)

The unit was first defined and named by Philippson (1915) in Western Taurus. Although the 'blocky flysch' (bloklü filiş) described by Philippson (1915) is not metamorphosed but still the meta-flysch in the study area are considered to be the metamorphosed equivalents of them, so 'Karaböğürtlen formation' name has been kept.

Blocky parts of the 'Karaböğürtlen formation' crop out in the North of Danyeri and the others having tectonic slices are in the west part of Naldöken Tepe. They are also found on the Eastern side of Karahöyük Tepe, southern slopes of Saylak Tepe, Naldökençal Tepe and in Kavak Tepe.

The 'Karaböğürtlen formation' in the study area was first determined by this study. It mainly consists of meta-conglomerates, meta-siltstones, calc-schists, re-crystallized limestones and marbles. It also includes blocks and tectonic slices of units of 'Kayaköy' and 'Çayderesi' formations. Meta-conglomerates at the bottom have been defined as 'Member'.

No fossil data has been found to appoint an age to the 'Karaböğürtlen formation'. But it includes blocks and slices of (?) Middle-Late Triassic-Cretaceous units and unconformably overlies the older units such as Pre and Late Permian. It suggested therefore that Karaböğürtlen Formation has developed as a result of low grade (green schist facieses) metamorphism of Late Cretaceous age blocky flysch.

3.6.1. Metaçakıltası (Meta-conglomerate) Member (Kkaç)

This unit has been defined and named for the first time in this study. It consists of meta-conglomerate and is located at the base of the Karaböğürtlen formation.

It crops out in the Naldökeniçal Tepe and in the North of Damyeri. It exhibits typical sections in the South Eastern slopes of Naldökeniçal Tepe.

Weathered surface of the meta-conglomerates have gray, beige like, blackish gray, pinkish colours. Freshly fracture surfaces display variegated - blackish colours. It has thin-medium-thick regular beddings, with karstic cavities and chert nodules. In the elongated matrix chert, dolomite and marble pebbles are present. Pebbles are 2-30 mm in size and display distinct lineation. They include pebbles belonging to 'Kayaköy formation' and also from older units.

Meta-conglomerates are 150 m thick and do not exhibit lateral continuity. No fossil data have been found for the meta-conglomerates forming the base of the 'Karaböğürtlen formation'

Meta-conglomerates at the base of the blocky flysch are believed to have developed at the early stage of the transgression. They were subjected to low grade metamorphism and are the covering unit of the Bolkardağ Nappe.

4. Results And Discussion

Metamorphic rock outcrops in the study area have been evaluated within the Taurus belt and considered as Bolkardağ Nappe. Tectono-stratigraphic character of the Bolkardağ Nappe has been determined. New data has produced for the metamorphic rocks present in the study area. Within light of this new data, metamorphic rocks have been defined as 'Formation' and 'Member' levels. The presence of Late Cretaceous meta-flysch has been brought to light and meta conglomerates in the meta-flysch have been defined at 'Member' level. The presence of Late Carboniferous has been shown in the field as well as proved with the paleontological data.

The metamorphic rocks in the study area were previously defined as crystalline rocks. Gültekin (1993) considered that metamorphic rocks were re-crystallized Kıratgediği Limestones of Jurassic-Cretaceous age overlying Carboniferous-Devonian Kangal formation with angular unconformity and he

classified these rocks as 'Bakırtepe meta-quartzite Member' and 'Düzce re-crystallized limestone Member' by considering them within the 'Kangal formation'. Regional geological settings and geographical distribution of metamorphic rocks in the area do not fit to the definition of 'Kangal formation'. In this study metamorphic schists in the area have been defined as 'Bolkardağ Nappe' of similar facies in the Central Taurus (Özgül 1976).

Acknowledgment

This paper includes some of the field study findings on the 'Geodynamic Evolution of Central Taurus (Sivas-Malatya-Kahramanmaraş-Kayseri)'. The project was conducted by the Geological Studies Department of Mineral Research and Exploration (MTA). Our thanks are due to the Directorate of the Geological studies Department of MTA. To the assoc. Prof. Dr. Cengiz Okuyucu and Dr. Erkan Ekmekçi (MTA) who carried out paleontological studies. Dr. Gonca Nalcıoğlu (MTA) conducted brachiopod definitions. Mr. Halil Keskin (MTA) read and edited the manuscript.

Received: 06.12.2012

Accepted: 06.08.2013

Published: December 2013

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