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

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1. Introduction


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 Karadaggeri 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 Hocalikova 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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Tectono-stratigraphic Characteristics of Alacahan-Çetinkaya Metamorphites

Yalçin 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 characterstics 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 ‘Geyikdağ Unit’, ‘Aladağ Unit’, ‘Bolkardag 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 (Titionian-Berriacian) (Tarhan 1982). The ophiolites in the area are considered to belong to the Southern branch of the Neo-Tethys and some parts have inner Taurus Oceanic origin (Şengör and Yilmaz 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 Yilmaz 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 Geyikdağ Unit is autochthonous; Aladağ, Bozkır, Antalya and Alanya Units are allochthonous.

The detailed descriptions of Geyikdağ, Aladağ and Bolkardag units were defined by Özgül (1997) in the Central Taurus. He reported that Aladağ and Bolkardag 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 Erenlersürt formation, late Permian Dumlutepe formation, Early-Middle Triassic Bastırik formation, Middle-Late Triassic Tozlutepe formation, Late Triassic Metrisyayla formation, Jurassic-Cretaceous Koçakkaletepe 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 Dağlıkaya 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 Aılı 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, Maastrichtian stage, and Miocene-present stage. In the pre-Maastrichtian stage, it appears two basins were present, one in the north of Gürrün Göreli autochthon, the other one in the south. Here northern and southern Ophiolites which were bound by the Gürrün para-autochthon started plunging northwards under the Taurid and Anatolid platforms during pre-Maastrichtian (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 (Beyazpirinç 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, Yeşiltaşyayla 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 (Beyazpirinç et al 2010).

3. Stratigraphy

Autochthonous and allochthonous units are present in the study area (Figure 2).
Tectono-stratigraphic Characteristics of Alacahan-Çetinkaya Metamorphites

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

3.1. Bolkardağ Nappe

Metamorphic rocks in the study area have been studied at member level in detail. They were previously named as Kangal formation (Gülekin 1993, Yağış 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 metamorphites (Perinçek, 1979a, 1979b), Kabaktepe and Cağilhan metamorphites (Tarhan, 1982, 1984), Keban-Malatya unit (Yilmaz 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,
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 Kinalar 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 Kinalar formation have been defined as ‘Bakirtepe 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.

![Diagram](Figure 3) Generalized tectono-stratigraphic columnar section of the study area.
3.2. Düzce Formation (Dd)

In the Kangal 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 Kinalar Village and on the southern slopes of the Kiratgediği Tepe. It consists of quartzites; sericite quartzites; chlorite, quartz mica-schist; slate; mica quartzites-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-chists 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 Brachipod 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 facies metamorphism of detritial and pelitic rocks in shallow water-slope environments.

3.3. Kinalar Formation (Ck)

Gültekin (1993) described this unit as Kinalar 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 Kinalar Village (Southern slopes of Cinalibaşı Tepe), Mollaosmançaşı Tepe, Karadağ Tepe and Bakir 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 sparatic 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 Kinalar 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 be observed, laterally it exhibits variations, in places it has carbonate lenses and layers.

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

Kinalar 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 Kinalar 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 lined 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 Kinalar formation.

‘Bakır Tepe member’ does not have any fossils. But as it is concordant with the Düze Formation at the top and is situated at the bottom of the Carboniferous Kinalar 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 Kebar-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 Kiratgediği 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 Kiratgediği Tepe. Rock types show lateral variations and have gastropod and crinoid pieces, Mizzia and Hemigordicous fossils in various parts.

Paleontological studies carried out on the collected samples identified the presence of Mizzia sp., Pseudovemiporella 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 Cinalibaşi 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 Wenynschek, Aulotortus? goschei (Koech-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’ (bloklu 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 Damyeri 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. Metaçakıltısa (Meta-conglomerate) Member (Kkaç)

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

It crops out in the Naldökeninçal Tepe and in the North of Damyeri. It exhibits typical sections in the South Eastern slopes of Naldökeninçal 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 metamorphic rocks in the study area were previously defined as crystalline rocks. Gültekin (1993) considered that metamorphic rocks were re-crystallized Kiratgediği Limestones of Jurassic-Cretaceous age overlying Carboniferous-Devonian Kangal formation with angular unconfirnity and he classified these rocks as ‘Bakırtpe meta-quarzite Member’ and ‘Düze 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 Oktaycu 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

References


Sayar, C., Gültakin, A. S. 1995. The stratigraphy, age and faunal community of Kangal formation (greenschist), Sivas, Turkey. Second International Turkish Geology Workshop, September 6-8, Cumhuriyet University, p.99, Sivas, Turkey. 81-181.


