THE CHRYSTALLINE ROCKS

AND

MINERALS

OF

SOUTHEAST ANATOLIA

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January, 2004

TABLE OF CONTENTS

PAGE

1. INTRODUCTION

Since the first living cell came into live; it has been affected by environment, which leads to evolution. In the evolution, mankind became the most generous living thing so that he began to try to use nature for his benefits; however he did not realize how he is destroying the equiliribium of the nature under the topic of civilization. This disturbance in the balance of nature also affected the human being which is also a component in nature.

While mankind was abusing the resources which the nature gave generously, he did not realize that he would encounter with health problems that he could not cope with. Now, those problems that can not be cured, brought the mankind to reason with nature.

This lesson made the mankind to consider the health problems and geology together. For example, new regulations have been made for the asbestos mine workers who were suffering from a lung cancer called mesothelioma. Even though material asbestos is tried to be substituted with another one which will not be malignant to the human.

These kind of precautions taken concerning the asbestos mine, coal mine and other industrial material mines workers, did not solve the problem. This was so confusing that people who never worked in or lived near to asbestos mines or others, were also suffering from the same carcinoma.

In Turkey in central Anatolia, there are villages known for their mesothelioma cancer, which is the reason for 42.9% of deaths in between 1970 and 1974 (Barış, İ.,1994). In fact those villages were not near an asbestos mine. It has been observed that the Capadocian realm is made up geologically recent volcanic ash deposits. Unconsolidated tuffaceous sediments are easily worked with hand tools, and inhabitants have plastered their home and other structures with those sediments (Barış, İ.,1994). Also tuffs are used as stucco pates and whitewashes for use in the interior and exterior of buildings. Minerologically Cappadocian soils and rocks showed that tuffs consisted of volcanic glasses, feldspars, and other silicate
minerals locally altered by ground water to montmorillionite and zeolite minerals (Önen, P., 2003 lecture notes).

Considering the southeastern Turkey unusual tumors of lung and pleura occurring in certain villages have been reported in Diyarbakır area. Those villages were Çermik, Çaparkayı, Cüngüş, Elazığ, Siverek, Kilis, Palu, Maden, Malatya, Adıyaman, Mardin (Barış, İ.,1994). This problem had called the attention and the risk map of South East Anatolia is tried to be constructed in this report.

2. STRATIGRAPHY

The non-sedimentary rocks of South East Anatolia were examined as the diseases are directly related to minerals especially needle like, asbestiform minerals. Only a very small and relatively rare group of mineral is considered hazardous to human health if present in high concentrations in dust and most of these are highly fibrous (Önen, P., 2003 lecture notes). Those are: Amphiboles Group such as hornblende, reibeckite, crocidolite, amosite, anthophyllite, tremolite, actinolite, Chrysotile Group such as chrysotile, antigorite, lizardite and other layer silicates such as kaolinite, vermiculite, montmorillonite, talc, muscovite, chlorite, sepiolite and polygorskite, Silica Group and Zeolite Group such as roggionite, mozzite, erionite and morderite. Most of the metamorphic and igneous, volcanic rocks contains these minerals. Weathering is an important aspect for those minerals to contaminate soils. Climate is also an important factor for those minerals during weathering process. Both together affect the fresh supply of minerals from rocks to biosphere which is the reason for diseases.

2.1. Regional Geology

South East Anatolia was a stable platform in the Early Cambrian, by the Middle Cambrian marine trangressions covered the whole region (Bozdoğan, N. and Ertuğ, K., 1997). Mardin – Kahta uplift controlled the sedimentation during the Ordovician in the central part and transgression covered the flanks of the uplift (Bozdoğan, N. and Ertuğ, K., 1997). Early Silurian is only reported from Nusaybin area and a worldwide rise in sea level in the Late Devonian –Early Carboniferous times lead to marine transgression in the southeast Anatolia. The region was a positive area in the late Carbonifer- Permian times (Bozdoğan, N. and Ertuğ, K., 1997).

The Southeastern Anatolia region is characterized by the Bitlis Pötürge massif metamorphics to East and West respectively and the flysh and associated ophiolite complex to the north and molasses type sediments to the south (Akıncı, Ö., 1983). The oldest fossiferous marine Cambrian formations extend along the Mediterranean coast, forming an unstable shelf region of the Alpine Taurid range (Akıncı, Ö., 1983).

In the Campanian, the northern edge of the Arabian Craton subsided and an elongate trough was formed in which relatively deep marine cherty shales and mudstones which gradually pass to marl and shallow marine limestones towards south were deposited and allocthounous ophiolite blocks were carried from the north. From the Upper Cretaceous to Miocene shallow marine sedimentary rocks were deposited over the allochtonous units. However volcanic activity continued up to the Eocene and Oligocene time along as a second belt located to the north of the trough. (Akıncı, Ö., 1983).

2.2. Major Crystalline Units

2.2.1. Bitlis Massif

The age of the massif is given as Devonian-Cretaceous (Göncüoğlu and Turhan, 1983; Perinçek, 1980; Çağlayan et. al., 1983). The southeast Anatolian Autochton with the Bitlis subunit represents the northern margin of the Arabian Plate to the South of the Pindos-Bitlis-Zagros suture. The Bitlis Metamorphics are cropping out around Cacas-Hani and Kozluk-Baykan-Sason towns plus Avnik area and near the valley Pervari town and Hakkari-Van towns and north of Narlı village with Çukurca town (See Appendix).

The Bitlis Metamorphic Complex is composed of numerous tectonic slivers consisting of discontinues sequences of pre-Lower Plaeozoic basement and its Paleozoic-Mesozoic Cover (Göncüoğlu, M. C. and Turhan, N., 1983). The basement comprises ortho and paragneisis with rare bands and lenses of eclogites, kyanite eclogites, meta gabrros and garnet amphibolites in its lower part (Göncüoğlu, M. C. and Turhan, N., 1983). The cover unconformably covering the basement rocks start with metaconglomerates and grades upward into variegated, crossbedded and well sorted meta quartzites. (Göncüoğlu, M. C. and Turhan, N., 1983).

Bitlis Metamorphic Complex is an Alpine structure in southeast Anatolia. It consist of large number of south verging slices of metamorphic and sedimentary rocks and represents the northern most edge of Arabian Platform, which has been deformed and metamorphosed during the closure of the southern branch of Neotethys (Göncüoğlu, M. C. and Turhan, N., 1983).

Bitlis massif rocks are mainly of the greenschist and amphibolite facies metamorphism and are locally intruded by granitic rocks (Akıncı, Ö., 1983). At the southern boundary of the massif glaucophane schists are reported. The northern edge of the massif is overlain by extrusive basic rocks and Neogene inner basin sediments to the west and east of Lake Van. To the south the margin of the Bitlis Massif is of tectonic nature and is referred as a gliding surface by Rigo de Righi and Cortesini (1964). From the north to the south the greenschist facies rocks and marbles are trust over which in turn are trust over the Permian marble bearing wild flysch zone. Paleocene flysch and ophiolitic wild flysch zones are associated with copper deposits (Akıncı, Ö., 1983). These imbrications zones are again trust over the foreland sediments.

Göncüoğlu and Turhan (1983) divided the Bitlis Metamorphics into two groups Hizan Group (pre-Devonian) and Mutki group (Paleozoic- Lower Mesozoic). The Hizan Group composed of gneiss, schist and metabasic rocks which show vertical and lateral gradation with one and other. The lower part of the unit contains biotite gneiss, garnet-biotite gneiss, muscovite-biotite gneiss, muscovite –garnet gneiss, albite-augen gneiss and hornblende-biotite-garnet gneiss in addition to the Andok Gneisses which contain scarce bands of metacoarbonets (Göncüoğlu, M. C. and Turhan, N., 1983). The Andok Gneisses composed of hornblende schist, amphibolite, garneteferous amphibolite, eclogite, kyanite-eclogite and meta-pigmatitic gabbro. The common primary mineral assemblage of the gneiss is as fallows: quartz, oligoclase, red-brown biotite, garnet, muscovite, tourmaline and the minerals are: chlorite, green biotite, albite, clinozoisite/epidote . the primarey mineral assemblages of the eclogitic rocks is given by: omphacite, garnet, Ca-amphibole, rutile, kyanite, clinozoisite, phengite, quartz. Symplectic textured clinopyroxene, plagioclase, light green amphibole, titanite and biotite are also common in gneisses. The assemblage Ca-amphibole, oligoclase, quartz, titanite, garnet, biotite is dominate in the amphibolites. The secondary minerals are represented by chlorite, clinozoisite/epidote , albite. The ordinary mineral assemblage in the schist is quartz, albite/oligoclase, muscovite, red-brown biotite, garnet, dark green amphibole, tourmaline, zircon (Göncüoğlu, M. C. and Turhan, N., 1983). The Mutki Group starts with coarse grained clastics comprise interclated politic rocks, refoidal limestones and felsic and basic volcanites and passes upward into carbonate rocks. The group is divided into formations but they will not be emphasized here separately. More than 90% of the rock is composed of quartz grains exhibiting wavy extinctions. Grains of muscovite, tourmaline, albite and opaque minerals are uncommon. The quartzite unit in the upper parts passes into quartz-abite-sericite schist, albite-sericite-chlorite schist and calcschist, the last of which is intercalated with chlorite schist, albite-epidote-chlorite schist, albite-epidote-calcite schist and metadiabase (Göncüoğlu, M. C. and Turhan, N., 1983). Albite-actinolite schist, albite-psilomelane-chlorite schist, graphite schist and albite-chlorotoid-sericite schist dominate the upper layers of the interbeded section which is thought to have originated from clayey sandstone, clayey limestone and volcanic rocks (Göncüoğlu, M. C. and Turhan, N., 1983). The other part of the unit is composed of fine grained recrystallized limestone, calcschist and greenschist. The massive part of the unit contains quartz, albite, phengite, clinochlore, zircon, apatite, tourmaline. The firne grained metatuffs contain albite, quartz, chlorite, phengite, clinozoisite (Göncüoğlu, M. C. and Turhan, N., 1983).

2.2.2. Koçali Complex

The age of the complex is given as Upper Jurrasic-Lower Cretaceous by Sungurlu (1973). The Koçali Complex outcrops at Amanos Mountains, to the south of Antakya near Yayladağ region, Kırıkhan, Osmaniye, Bahçe towns at Kızıldağ, İskenderun Dörtyol, Haruniye, Kahramanmaraş, to the west of Amanos high, Karasu –Hatay graben, Musabeyli Burç high, Sakçagöz village, Pazarcık-Gölbaşı area and Besni town, Göksu valley, Hayıtlıdere, Başaktepe and north of Adıyaman, Çelikhan, Şerefli village, Sincik-Polikan area, Gerger anticline and north of Kervan, Diyarbakır area, Korudağ, Çermik, Cüngüş, Ergani towns, southeast of Abdülaziz mountain, Yüksekova town, Dağlıca village, Cilo mountain and Sat Lake area (See Appendix).

The Koçali Unit composed of serpantinites, sedimentary units and volcanics, which are trusted over Karadut Unit. The serpentinites seen at the upper most layer of the Complex is the base of the Koçali Complex at the time of deposition whereas the volcanics which are observed at the bottom today were at the top during the primary settlement (Sungurlu, O., 1974).

The serpentinites of the Koçali Complex is located to the north of Adıyaman, Gölbaşı-Gerger town and Korudağ-Çermik-Cünğüş area. The thickness of the serpentinites of Koçali Complex is over 500m at the center of Boğazköy high (Özkaya, İ., 1978). The upper most part of the unit consist of serpitinite, diorite, diabase and gabbro, near the Hakkari town Cilo mountains. It is composed of ophiolitic rocks.

Koçali Complex was divided into three by Perinçek (1978 ve 1979) as Tarasa, Konak and Kale from bottom to top. Tarasa Formation contains basalt, diabase, spilitic basalt where as Konak Formation is represented by limestone, volcanic radiolarite shale and sandstone.the Kale Formation is composed of serpentinites, diorite, diabase and gabbro.

2.2.3. Karadut Complex

The age of the complex is Cenamanian- Lower Touronian (Sungurlu, O., 1973). The complex crops out to the south of Yayladağı town, Keldağ area, Balıkgölü, Osmaniye town, north and west of Haruniye village, west of Sabunsuyu river, Pazarcık-Gölbaşı-Kahramanmaraş area, west of Suvarlı, Besni anticline, south of İnişdere, Sepker river, Tut-Penbeğli area, Çelikhan-Sincik, Koçali area, Karadut-Perdeso-Gerger area and Gerger high, Kevan –Korudağ structure, Yogun-Çakmak area, west of Çermik town, north of Çermik-Ergani road, Yüksekova town and Cilo mountains (See Appendix). It is flysch sequence composed of silicified limestone, clayey limestone, conglomeratic limestone, turbiditic limestone, cherts, marn and shale lithologies (Tuna, E., 1973). Conglomerates contain ultrabasic pebbles which are altered.

2.2.4. Yüksekova Complex

The age of the complex is given as Coniacian-Campanian by Perinçek (1989). The complex crops out at Elazığ town, Palu-Pertek area, north of Beytüşşebab town, northwest of Hakkari town and east of Geçitli village, Yüksekova village and Cilo Mountains (See Appendix). It consists of spilitic basalt, volcanic sandstone, diabase, gabbro, serpentinite limestone, granite, granodiorite, tuff, shale, mudstone, conglomerate and flyschoidal facies. Pebbles are composed of sileksite, radiolarite, limestones and volcanic rock fragments. Spilitic basalt and pillow lavas have calcite amigdoloidal fillings. Near the town of Geçitli the complex has granodiorite, quartz diorite and quartzphorphry type rocks.

2.2.5. Guleman Group

The age of the group is given as Jurassic-Lower Maastrictian (Akıncı, Ö., 1983). The group crops out Adıyaman, Çelikhan-Sincik Koçali, north and northeast of Kalikan, south of Lagin village, Diyarbakır Cüngüş town, Elazığ Maden town, Cacas Hani area, Nerzik, Hınzı, Hanza and Harbat villages at Kulp river valley, Van and Gavgas village at Çemilgeldano river valley, Siirt Baykan-Şirvan towns and Hakkari town area (See Appendix). The group is mostly serpentinized at the outcrops where diabase, gabbro, basalt and pyroxenite are also observed. Near Elazığ town the Guleman Group composed of 4000m thickness and generally dunite, and chromite harzburgite, verlite-clinopyroxenite, troktolite/olivine gabbro, gabbro, quartz gabbro and quartz diorite.

The Guleman group is divided into three units by Akıncı (1983). those are: the serpentinized peridotite, banded gabbro with pyroxenite layers, the thoelitic basaltic pillow lavas with diabase dykes.

2.2.5.1. Guleman Chromite Deposits

Guleman is an important chrome production ore producing in Turkey SE Anatolia. The history of the chromite mining in Guleman goes back to 1936. Since than 7000000 tons of metallurgical grade ore have been produced from the area. The annual production of Guleman area is about 150000 tons mostly of metallurgical grade. Field data indicate that Guleman ophiolite was developed in Upper Jurassic – Lower Cretaceous. In Guleman ophiolite rock types are harzburgite, dunite, pyroxenite, wehrlite, troctolite, gabbro, dolerite and plagiogranite.

Guleman ophiolite is estimated to be about 10km thick and it has E-W elongation. Chromite deposits are scattered all through the peridotite but concentrations of the deposites towards the eastern end of the peridotite body is noticeable (Engin, T., 1983).

2.2.6. Hakkari Complex

The age of the comlex is given as Eocene by Özkaya (1978a). The complex crops out at Hakkari town, north of Çukurca high, Yüksekova and Şemdilli towns and Cilo mountains (See Appendix). The lower parts of the complex is composed of sanstone shale alternation with limestone clayey limestone (Özkaya, İ., 1978a). Blocks and pebbles derived from serpentinites are observed in the unit. It is the Southeastern equivalent of Maden Complex (Özkaya, İ., 1978b). The important deference in between the two complex is that Hakkari unit does not have volcanics and the sequence composed from shale, phyllite, sandstone and siltstone alternation in Hakkari complex does not exist in Maden Complex.

2.2.7. Maden Complex

The age of the complex is Lower-Upper Eocene (Perinçek, D.,1989). The complex crops out at Adıyaman town, Çelikhan-Sincik-Koçali town, Malatya Tepehan town, Diyarbakır

Cüngüş area, to the northeast of Cüngüş-Çermil road, near Ergani-Maden-Hazar-Elazığ area, Batman Sasaon and Kozluk towns, Siirt Baykan-Şirvan-Pervari area Arbo village, Narlıdere village Bingöl Karadere village Van town and Narlı village (See Appendix). It is composed of spilitic basalt, diabase, limestone, spilitic diabase, marn, mudstone, sandstone, and siltstone litholoies (Sungurlu, O., 1974).

The group is divided into lower volcano sedimentary unit at the bottom and an upper volcanic unit at the top (Akıncı, Ö., 1983). The lower volcano sedimentary units begins with the basal conglomerate overlain by reddish and grayish mudstones. The reddish and grayish mudstones contain nummulites indicating Maastrichtian- Middle Eocene age (Erdoğan, B., 1982). Upper volcanic unit consists of pillow lavas, basaltic agglomerates and tuffs. The age of the unit is thought to be Oligocene (Akıncı, Ö., 1983).

2.2.7.1. Maden Copper Mine

The Maden pyritic copper mineralization which is situated 50km southeast of Elazığ has been known since 2000 years B.C. It occurs in the ophiolitic belt of Taurid Tectonic Unit and shows some similarities to the Cyprus type deposits formed at sites of sea-floor spreading. Almost all deposits along this belt are pyretic copper associated with sipilitic pillow and diabase lavas. Two important deposits of this belt are located at Maden near Ergani in the west and Siirt Madenköy in the east.

The copper deposits are composed of 1-Serpentinite and Gabbro,2-Pillow Lava, Diabase, Volcanite and Mudstone Complex and 3-Calcerous Mudstones and Sandstones (Akıncı, Ö., 1983). The serpentinites which is made up of massive crysotile and antigorite is found at the base of main sulphide ore body. To the south of Anayatak unaltered dunite and pyroxenites are seen within the serpentinite. Gabbros are exposed at the northwestern end of the open pit as well as the area to the east of Anayatak. In the area a massive saussurite gabbro and a schistose gabbro are also distinguished (Bamba, T., 1974). The second group defiend as Pillow Lavas, Diabase, Volcanite and Mudstone Complex are distincitive with their greenish black colors due to extensive chloritization (Akıncı, Ö., 1983). To the south of Maden town unaltered pillow lavas and volcanites are exposed over the serpentinites. Within this complex unit there are chlorites or chlorite rocks which are formed only on chlorites. In the pit area there are also magnetite bearing chlorite rock blocks of varying sizes (Akıncı, Ö., 1983). Cherts contain no magnetite but pyrite and chalcopyrite are dominant (Akıncı, Ö., 1983).

The Anayatak suphide ore body was described as roughly elliptical in shape about 350m long and 160m wide. The main sulphide body ends abruptly against the roof of slightly to strongly chloritized sedimentary rocks (Akıncı, Ö., 1983).

The ore minerals are readily identified in the field are chalcopyrite, pyrite and magnetite (Akıncı, Ö., 1983). The fallowing primary and gangue alteration minerals and mineral associations were identified by Çağatay (1977). Those are: *pyrite, narcasite, melnicovite-pyrite, native gold****;*** *chalcopyrite, bornite, valleriite, cubanite, chalcocite****;*** *covellite, dignite, cuprite,tenorite, malachite, azurite****;*** *sphalarite, galena, molybdenite****;*** *pyrrhotite, Co-pentlandite, cattierite, linneite, glaucodote****;*** *chromite, Cr-spinel, magnetite, hematite, maghemite, limonite****;*** *ilmenite, rutile, anatase, leucoxene, titanite****;*** *chlorite, barite, siderite, dolomite, calcite****;*** *actinolite, tremolite, talc, quartz, ilvanite.*

Chlorite is the dominant gangue mineral, cubanite and valleriite are observed as exolved pahses. Transformation of chromite to magnetite through Cr-spinel and colloidal replacement and flow textures are vein mineralization with pyritized fossil casts are common (Akıncı, Ö., 1983).

Generally the massive magnetite, chromite, pyrhotite and the Co-Ni mineral associations gives way upward to pyrite and Cu-suphides with subordinate sphalarite and galena (Akıncı, Ö., 1983). The proven reserve is 11.7 million tons for Anayatak with 1.77% Cu grade (Akıncı, Ö., 1983).

3. INDUSTRIAL MINERALS

3.1. Basalt and Diabase

Basalt is the entire equivalent of Gabbro and it is hard and resistant. It is used as a grit in the cement used for road, dam construction and also used in the railroads. It is also used in the cement of walls of nuclear reactors. The specific quality of basalt and diabases is suitable for constructions material and also they are resistant to chemical and mechanical weathering factors. They have to be non--.reactive, and they should not have asbestos and zeolite minerals. Basalt and diabases are wide spread in Turkey, and there are quarries in Diyarbakır, Elazığ, Gaziantep, Urfa, and Kahramanmaraş.

3.2. Asbestos

Geologically asbestos is used to define serpentine and amphibolite minerals. Mineralogically, serpentine mineral chrysotile and amphibole minerals, crocidolite, amosite, tremolite, actinolite and antophyllite are called asbestos.

Chrysotile	$[Mg_6(OH)_6 Si_4O_{10}]$
Crocidolite	$[Na_2Fe_5Si_8O_{22}(OH)]$
Amozite	$[(MgFe)_7Si_8O_{22}(OH)]$
Tremolite	
Actinolite	
Anthophyllite	$[(MgFe)_7Si_8O_{22}(OH,F)_2]$

The occurance of chrystal asbestos beds is related to serpentinization. The asbestos occurs from the serpentinization of either ultrabasics, or dolomites (Hess, 1983). The occurance of amphibolite asbestos beds are related to the hydrothermal alteration of ferrousilicate rocks enriched with sodium. Anthophyllite, tremolite and actinolite occurs at the contact of acidic rocks at ultrabasic rocks.

Asbestos is resistant to high temperatures and chemical effects. In Turkey untill 1985, there had been more than 10chrysotile asbestos beds (3 million ton) were recognized however; production is very limited. In Southeast Anatolia at Kızıldağ area there is a chyosolite asbestos quarry with 2.2 million ton of reserve. The other chysolite asbestos beds are at Bitlis, Beykan and Siirt.

3.3. Garnet

The garnet name is given to the general formulated minerals of $[A_3B_2(SiO_4)_3]$. A represents Ca, Mg, Fe, Mn and B represents Al, Fe, Ti and Cr. They occurred mostly in magmatic and metamorphic rocks. They are in peridotites, grossular magmatic intrusive at contact with limestone almandine micashcists, and in uvarovite. They are used as .depreciation material. The red colored ones are used as gemstone. In Turkey the real reserve amount of garnet minerals are not known and there is no production.

3.4. Granite

Granite is used for different rock groups such as .gneiss, syenite, quartz monzonite, granodiorite, gabbro, diabase, anortozite and pyroxenite. It is produced as grit and block. The granite grits are used especially in road construction, railroads construction, water well screenization, breakwater construcrtion and dam construction. The block granites are used in the foundation stones of buildings, pavement stones and tombstones. The color of the granite is controlled by the amount of quartz inside. Generally the color changes from pinkish to grey to dark red. Biotite and hornblende controls the color to be light grey to dark grey.

3.5. Mica

Mica is an aluminum silicate and the muscovite and flagopite are the economically important minerals. The muscovite reserves occurs in pigmetites. Muscovite are occurred by the metasomatism of feldspars, garnets, tourmaline, apatite and rare earth elements and sulphides, albites and serisites follow the muscovite occurrence. Flagopite are mostly occurred by hydrothermal alteration. The acidic intrusions in ultrabasic rocks favors the flagopite occurrence and olivine and pyroxene are found together with it.

The major muscovite beds are found in Lice (Diyarbakır) and Çermik area.

3.6. Olivine (Dunite)

Olivine is the main constituent of dunite. Also it has high concentrations in gabbro, peridotite and basalt. The fosterites are obtained from dunite is an important mineral. Generally magnetite, chromite, ilmenite and garnet are found together with fosterite.

Olivine has an important advantage against quartz. Olivine does not make silicosis as quartz. The foaterite is also used in glass, ceramic and electrical industry. Turkey has an important reserve of dunite. The most important reservers are found in Guleman Elazığ, however olivine is not produced in Turkey.

3.7. Prophyllite

It is an hydrate aluminum silicate mineral (Al_2 Si_4 O_{11} H_2O), generally in asbesti form shape. Mostly found in metamorphism of rhyolite, dacite and andezite and hydrothermal alteration.

The most common reserves are found as lenses in schists or altered tuffs. The industries using prophyllite are white cement, tire, detergent, soap and textile.

The economical reserves of prophyllite are found at Pötürge (Malatya). Also quartz, muscovite, tourmaline, rutil, topaz, diaspor and pyrite are found together with prophllite.

3.8. Pyrite

Pyrite is used to obtain sulfer and sulphide. It destroys the environment and causes acid rains. The major occurrence of pyrite is with hydrothermal alteration. Pyrite is found together with chalcopyrite, saphalerite,galenite, arsenopyrite, and marcasite. The Ergani (Diyarbakır) copper mine has pyrite concentrations and they are used in Turkey's consumption.

3.9. Vermiculite

Vermiculite occurs by hydrothermal alteration of ultrabasic rocks containing olivine, pyroxene, amphibole where biotite and flagopite come into wiev by hydrothermal alteration. They mostly occur around 100m below surface and beds are located at fault zones. Biotite, chlorite, quartz, feldspar, talc, asbestos and corundum always found in its paragneisis. They are used in heat and noise isolation and in electrical industry.

In Turkey at Darende, Malatya area more than 6million tons of vermiculite reserve is found; however there is no production.

4. CONCLUSION AND DISCUSSIONS

The towns, villages and areas which are located at these crystalline outcrops which are harmful for human being are listed below: Cacas, Hani, Kozluk, Baykan, Sason, Avnik, Pervari, Hakkari, Van, Narlı, Çukurca, Amanos Mountain, Yayladağ, Kırıkhan, Osmaniye, Bahçe, Kızıldağ, İskenderun, Haruniye, Karasu, Hatay, Musabeyli, Burç, Sakçagöz, Besni, Göksu valley, Hayıtlıdere, Başaktepe, Çelikhan, Şerefli, Sincik, Polikan, Gerger, Diyarbakır, Korudağ, Çermik, Cüngüş, Ergani, Abdülaziz Mountain, Yüksekova, Dağlıca, Cilo, Sat Lake, Balıkgölü, Sabunsuyu, Pazarcık, Gölbaşı, Kahramanmaraş, Suvarlı, İnişdere, Sepker, Tut, Penbeğli, Koçali, Karadut, Perdeso, Kevan, Yogun, Çakmak, Elazığ, Palu, Pertek, Beytüşşebab, Geçitli, Şemdinli, Adıyaman, Kalikan, Lagin, Maden, Nerzik, Hınzı, Harbat, Kulp river, Gavgas, Çemilgeldano river, Siirt, Şirvan, Tepehan, Hazar, Batman, Arbo village, Narlıdere, Bingöl, Karadere (See Appendix).

These areas are mostly located to the north of Southeast Anatolia where too much tectonism and trust zones are present. This zone is the result of collision of Arabian Platfrom with Anatolite, closing the southern branch of Neotethys. That is why there are too much chrytalline rocks such as remnants of ocean floor and trusting and metamorphism of rocks. Those hazardous minerals are mostly found in these outcrops of crystalline rocks. The living standards of these areas are very low; only few towns have good economical and living conditions such as Diayrbakır, İskenderun-Hatay, Osmaniye.

As a result it is not surprising to have enormous amount of application to the Diyarbakır hospital. This is because Diyarbakır has the biggest hospital really having all the formation of medical sciences in the eastern part of Southeast Anatolia. The people living in the western parts as Osmaniye, Kızıldağ, Hatay could have been using their home town hospitals or the hospitals in Gaziantep. The Maden Copper Mine and the Guleman Chromite Mine and their surrounding area should be taken into strict consideration from the point of regulations and also treatment of health problems.

On the contrary there are many economical reserves located in Southeast Anatolian crystalline rocks, which are waiting to be an income in our countries economy. When the conditions of Turkey and growing economy taken into consideration these deposits will going to be operated by either international or national capitals and when the related environment regulations delayed than the morbidity in the region can not be succeeded. So the other urgent issue is to put forward the right regulations for mining industry very soon.

The most risky areas are tried to be pointed out and the risky minerals found in those crystalline rocks are tried to be revealed by this study. It is being seen that; the Southeast Anatolia is rich in economical mineral deposits. However, the desire is that, it will not be rich in the morbidity and it is not desired that one of the areas located in that region will bear in mind as Karain village does. As a last word it is hoped that this report will be a milestone to the studies that are going to be carried in the region by geologists and doctors for the sake of societies health.

REFERENCES

Akıncı, Ö., 1983, Ergani copper mine, Mineral Deposits of the Eastern Taurus **in**: International Symposium on the Geology of the Taurus Belt, **eds:** Tekeli, O. and Göncüoğlu, M.C., *Field Guide Book for Excursion VI, p.5-10.*

Bamba, T., 1974, Copper deposits in the Ergani mining district southeastern Turkey, *Mining Geology, v. 24, p.297-305.*

Barış, İ., 1994, Bu doktoru rehin alalım: Anadolu'da bir kanser araştırması, *Ajans –Türk Matbaa Sanayi, Ankara, 112p.*

Bozdoğan, N. and Ertuğ, K., 1997, geological evolution and paleogeography of the southeast Anatolia in the Paleozoic, **in:** Early Pleozoic Evolution in NW Gondwana Proceeding, **eds:** Göncüoğlu, M.C. and Derman, A.S., *Türkiye Petrol Jeologları Derneği Special Publication No:3, p.39-49.*

Çağatay, A.,1977, Güneydoğu Anadolu bakır yatak ve zuhurlarının jeolojik minerolojik etüdü sonucunda elde edilen jenetik bulgular, *Maden Tetkik ve Arama Dergisi, v.89, p.46-69.*

Çağlayan, M. A., İnal, R. N., Şengün, M. and Yurtsever, A., 1983, Structural setting of Bitlis Massif, **in**: International Symposium on the Geology of the Taurus Belt, **eds:** Tekeli, O. and Göcüoğlu, M.C., *Geology of the Taurus Belt, Proceedings, p.245-254.*

Engin, T., 1983, Guleman chromite deposites, Mineral Deposits of the Eastern Taurus **in**: International Symposium on the Geology of the Taurus Belt, **eds:** Tekeli, O. and Göncüoğlu, M.C., *Field Guide Book for Excursion VI, p.1-4.*

Erdoğan, B., Dora, O. Ö., 1982, Bitlis Masifi apatitli demir yataklarının jeolojisi ve oluşumu, *Türkiye Jeoloji Kurultayı Bülteni, c.26, s.133-144.*

Göncüoğlu, M. C. and Turhan, N., 1983, Geology of Bitlis Metamorphic belt, **in**: International Symposium on the Geology of the Taurus Belt, **eds:** Tekeli, O. and Göcüoğlu, M.C., *Geology of the Taurus Belt, Proceedings, p.237-244.*

Önen, P., 2003, Medical Geology, *Lecture notes, Middle East Technical University.Department of Geological Engineering.*

Özkaya, İ., 1978a, Ergani Maden yöresi stratigrafisi, *Türkiye Jeoloji Kurumu Bülteni, v.21, p.129-139.*

Özkaya, İ., 1978b, Yüksekova Şemdinli yöresi jeolojisi, *Türkiye Dördüncü Petrol Kongresi Tebliğleri, s.63-81.*

Perinçek, D., 1978, Çelikhan-Sincik-Koçali (Adıyaman) alanının jeolojik incelemesi ve petrol olanakları, (İÜFF Tatbiki Jeoloji Kürsüsü, Doktora Tezi) ,*TPAO Arama Grubu, Rap. No: 1250, 212s.*

Perinçek, D., 1979, Çelikhan-Sincik-Koçali (Adıyaman) alanının jeolojik incelemesi, *TPAO Arama Grubu, Rap. No: 1394, 30s.*

Perinçek, D., 1980, IX. Bölge Hakkari, Yüksekova, Çukurca, Betüşşebab, Uludere, Pervari dolayının jeolojisi, *TPAO Arama Grubu, Rapor No:1481, 80s.*

Perinçek, D., 1980, Bitlis metamorfitlerinde volkanitli Triyas, *Türkiye Jeoloji Kurumu Bülteni, v.23, No.2, s.201-211.*

Perinçek, D., 1989, Hakkari ili ve dolayının stratigrafisi, yapısal özellikleri, petrol imkanları, *TPAO Arama Grubu, Rap. No: 2545, 127s.*

Rigo de Righi, M. and Cortesini, A., 1964, Gravity tectonics in the foothills structure belt of Southeast Turkey, *American Association of Petroleum Geologists Bulletin, v.48, No:12, p.1911-1937.*

Sungurlu, O., 1973, VI. Bölge Gölbaşı-Gerger arasındaki sahanın jeolojisi, *TPAO Arama Grubu, Rap. No: 802, 30s.*

Sungurlu, O., 1974, VI Bölge kuzey sahalarının jeolojisi, *2. Petrol Kongresi Tebliğleri, p.85-107.*

Tuna, D., 1973, VI. Bölge lithostratirafi birimleri adlamasının açıklayıcı raporu, *TPAO Arama Grubu, Rapor No:813, 131s.*