# Genetic Types of Alpine ore Deposits and Tectonic Settings in the Northeastern Mediterranean and Southwest Asia

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With 1 Figure

**Zusammenfassung**

Die metallogenetischen Bezirke des „Tethyan-Eurasian Belt" zwischen SE-Europa und Mittel-Asien werden in regional-temporaler Folge beschrieben: 1. Bezirke des triassischen Rifting, 2. Bezirke des Ophiolithgürtels, 3. Bezirke der Subduktionszonen, 4. Bezirke der kontinentalen Plattenkollision, 5. Bezirke einer jüngeren endogenen Mineralisation. Bei allen Erzbezirken werden die Lagerstättentypen in genetischen Klassen aufgezählt und durch Beispiele belegt. Gegenüber den altbekannten südosteuropäischen Beispielen bringen die Ausführungen über die westasiatischen und zentralasiatischen Lagerstättenbezirke grundsätzlich Neues. Das gilt auch für den bisher unbekannten vulkano-sedimentären Sb-Tl-Lagerstättentyp jungtertiären Alters in der Türkei.

**Summary**

The Alpine ore deposits of the northeastern Mediterranean and southwest Asia are associated with a part of the Tethyan Eurasian metallogenic belt (JANKOVIĆ, 1976), and they are situated along the southern margin of the Eurasian plate in the domain between the Afro-Arabian and the Indian plates in the south, and the Eurasian plate in the north. The tectonic evolution of this area is in close connection with the development of the Tethys oceans – the closure of the Palaeo-Tethys and opening and evolution of the Neo-Tethys, its margins and island arcs, convergence, closure, subduction of oceanic crust(s), continent-continent collisions, and development of magmatic complexes and volcano-intrusive belts and zones.

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The emplacement of ore deposits in the area under consideration is related to a definite time interval, and a specific tectonic setting:

## 1. Intracontinental rifting

The intracontinental rifting along the northern margin of Gondwanaland and/ or within its already separated fragments is particularly widespread during the late Permian-Middle Triassic and the late Triassic-early Jurassic, but intracontinental rifting took place locally even later during the Eocene-Miocene interval; the deep penetrating fractures in the Sistan block in Afghanistan in the Quaternary and the carbonatite deposit may belong to this type of tectonic settings.

The lateral spreading of continental crust and commencement of drift produced its thinning, forming the graben floor, by deep crustal flowage and tensional faulting. These processes in the area under consideration are largely of a short life span and failed to achieve the stage of development of oceanic floor features. But locally, the sea-floor spreading along rift system continues right to the stage of oceanization, i. e. the development of a floor of oceanic crust such as in the area of Mirdita in Albania. Intracontinental spreading axes are closely similar to mid-ocean ridges, but there are differences because the geothermal field linked with the spreading is not dissipated by great volumes of oceanic water.

Apart from thinning of the underlying continental crust and high heat flow caused by rising mantle current, the intracontinental rifting is often accompanied by basic and intermediate volcanism derived from contaminated basic (mafic) magma (the spilite keratophyre complexes), in places by the alkaline complexes, as well.

The ore metals originated from the intermediate, mafic or alkaline magmatic complexes, and/or from hydrothermal mobilization from the surrounding rocks. In some areas volcanic sources at depth supplied only heat which drives hydrothermal systems. Apart from submarine exhalations, hot solutions and metal-rich muds in some basins, there exist intracontinental mineral-bearing basins without volcanic activity, the mineralization of which is associated with shallow-water environment, while the sources of metals are most probably non-volcanic.

The following main genetic types and metallogenic environments can be distinguished, both in the Northeastern Mediterranean and Southwest Asia:

1. Volcano-sedimentary and volcanogenic hydrothermal deposits, both syngenetic and epigenetic are related to volcanic activity, close and/or at the floor of a epicontinental sea. Locally, ore deposits are related to subvolcanic intrusives (diorite, even gabbro).

Among ore deposits the most significant are the following:

1.1. The proximal and distal hydrothermal volcano-sedimentary lead-zinc deposits ("massive sulphide type"), locally accompanied by barite (the deposits: Brskovo and Bobija in Yugoslavia).

1.2. Bedded ferromanganese oxide and iron carbonate (the Vares deposit in Yugoslavia).

Scarcity of major copper deposits is a specific feature of such metallogenic environments.

1.3. Hydrothermal veins and disseminated lead-zinc sulphides in the volcanics (the Suplja Stijena deposit in Yugoslavia).

2. Low temperature hydrothermal deposits related to the marginal seas are usually located close to continental margins, forming elongated metallogenic zones near the continental margins.

2.1. Low temperature Pb–Zn–Ba±F association in the carbonate rocks are usually distributed along the continental margin (the lead-zinc deposits in Central Iran, the lead-zinc-barite deposits in Baluchistan, Pakistan – JANKOVIĆ, 1983; the Borovitsa-Olovo-Zavlaka zone in the Dinarides – JANKOVIĆ, 1967).

Hydrothermal siderite mineralization (stratiform and vein types) occurs often in the vicinity of Pb–Zn mineralization and/or as subordinate mineral constituent of the low temperature Pb–Zn±Ba association in the carbonate rocks.

2.2. The Triassic lead-zinc deposits in the carbonate rocks (Bleiberg, Raible and Mezica in the Alps; the Silesian ore deposits in Poland).

3. Skarn deposits are scare (the magnetite deposit at the gabbro/limestone contact – Tovarnitsa in Yugoslavia – JANKOVIĆ, 1982).

4. Hydrothermal syngenetic and epigenetic mercury mineralization is largely confined to active plate margins where geothermal gradient was sufficient to mobilize it from the mantle (in the Dinarides in Yugoslavia: the Idrija deposit – MLAKAR and DROVENIK, 1971; the Great Caucasus).

5. Carbonatite deposits have been found so far in North Pakistan (the Loe Shilman deposits) and in South Afghanistan (the Quaternary Hanneshyne deposit – ABDULAH and CHMYRIEV, 1980). They are associated with alkaline rocks.

## 2. Mineralization associated with opholites

When the lateral spreading of continental crust continues from the stage of intracontinental rifting, new oceanic crust begins to be formed and a mid-oceanic ridge develops. The floor of the ocean has many tectonic elements that are considered to be significant metallotects of ore deposits (the active spreading axes, hot-spots, convection currents etc.).

Within an ophiolite assemblage, three groups can be distinguished, each being characterized by specific metallogenic features:

a) a plutonic group of ultramafic and mafic (gabbroic) rocks,

b) a silicic plutonic group that ranges from quartz diorite to plagiogranite; whereas the ultramafics and gabbro are allogenic rocks (Jackson and Thayer, 1972), the plagiogranites were intruded as fluid magma into the mafic plutonic rocks after their principal deformation, ofter overlapping the early stages of sheeted dyke intrusion*), and

c) a volcanic and volcano-sedimentary rocks (swarms of basalts dykes, overlying flows, and deep-sea sediments); the volcanic rocks display major structural discordance with gabbro and peridotite.

Among the ore deposits associated with ophiolite suites in the NE Mediterranean and SW Asia, endogenous as well as exogenous ore deposits can be distinguished as two principal types:

### 2.1. Endogenous ore deposits

2.1.1. Magmatic deposits are related to both ultramafics and mafic complexes:

Chromite deposits: Numerous podiform chromite deposits are known in the area under consideration. The dunite is usually the country rock; the harzburgite seldom host chromite deposits, and pyroxenite – exceptionally only.

Apart from typical podiform, there are deposits clearly exhibiting features of stratiform type.

Platinum mineralization is rarely found (Veluce in Yugoslavia – Janković, 1967; traces in the Troodos complex).

Ni–Cu–Co sulphides (pyrrhotite – chalcopyrite – pentlandite ± magnetite association accompanied by gold and silver) are locally found in serpentinites, mainly of small size. They often exhibit transition into hydrothermal stage (Petkovic in Yugoslavia – Janković, 1967).

The scarcity or even lack of sulphides in the Alpine peridotites, both residual and cumulate peridotites and gabbro, in the NE Mediterranean is due to the removal of S in the melt formed by partial fusion, as suggested by Naldrett (1973) for residual Alpine peridotites. It is not quite certain whether a large-scale desulphurization of the upper mantle really tooks place as argued by Naldrett (1973).

Magnetite deposits occur occasionally in some serpentinized ultramafics. Mineral association consists of magnetite and subordinate amounts of Ni–Cu–Fe sulphides (Lipovac in Yugoslavia – Janković, 1967).

Titanoferrous magnetite veins and disseminated mineralization occur occasionally in the gabbro, accompanied by traces of chalcopyrite and pyrite. They are mainly of small size (Rastishte, Tara mountain in Yugoslavia – Janković, 1967; Szarvasko in Hungary – Lengyel, 1957).

2.1.2. Volcano-sedimentary deposits include two principal types, occasionally lying in the same ophiolite complex:

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*) In some regions, the ultramafic and gabbro group occurs without silicic plutonic and volcanic rocks.

Bedded ferromanganese deposits are usually associated with pillow lavas and with tuffaceous beds between flows or with overlying marine sediments. These Fe—Mn oxides interbedded by chert display often colloform textures. They are numerous in the NE Mediterranean, but small in size.

Sea-floor sulphides (pyritic copper sulphides – the Cyprus type) were probably formed by interreaction between sea water and hydrothermal ore-bearing solutions from deep-seated volcanic and meteoritic water sources; the ore metals originated from the volcanics from which they were mobilized by hydrothermal solutions.

These deposits are numerous in the NE Mediterranean and SW Asia, but they are mostly of small size (up to a few million tons of ore, exceptionally 20 to 30 million tons).

## 2.2. Exogenous deposits

These deposits were mainly formed by agencies unrelated to the original ophiolite long after crystallization and emplacement. The ore metals originating from the ophiolites were mobilized and transported to the precipitation site by hydrothermal solutions and/or cold water. Hydrothermal solutions are mainly related to younger magmatic activity as the source of heat, while the water is mainly of meteoric origin.

Table 1 shows the principal exogenous deposits in the area of the NE Mediterranean.

Table 1. Principal types and mineral associations of the exogenous deposits in the NE Mediterranean and SW Asia

| Type | Mineral composition | Deposit |
|---|---|---|
| | Magnesite in serpentinite | Vavdos and Eubea, Greece; Petrascheck 1961<br>Goles, Yugoslavia – Janković, 1982 |
| Hydrothermal/ Metamorphic: | Asbestos: Chrysotile ± Amphibole | Korlača, Yugoslavia–Vakanjac, 1964<br>Zidiani, Greece |
| Vein and/or stockwork | Talk | |
| | Magnetite | Mineralization only. See: Paraskevopoulus and Economou, 1980 |
| Hydrothermal-sedimentary | Magnesite | Bela Stena and Beli Kamen, Ilić in Yugoslavia |
| Sedimentary | Magnesite – Huntite – Hydromagnesite | near Servia, North-Greece |
| Residual | Lateritic nickel deposits | Goles-Mulina in Yugoslavia, Maksimović, 1966 |

Table 1. (Continued)

| Type | Mineral composition | Deposit |
|---|---|---|
| Redeposited | Lateritic nickeliferous iron deposits | Kukës a. a., Albania (Pumo et al., 1982); Larymna, Greece (Albandakis, 1974); Rzhanovo (Ivanov, 1962), Mokra Gora (Janković, 1967, 1982) in Yugoslavia |
| Marine placer | Chromite, Ilmenite, magnetite | Ulcinj, Yugoslavia |

## 3. Mineralization in subduction-related settings

Along the southern margin of the Eurasian plate, above the subducted Afro-Arabian and Indian plates, very significant non-ferrous hydrothermal deposits have been formed. These highly mineralized sectors of the Tethyan Eurasian metallogenic belt are mainly associated with the volcano-intrusive complexes of calc-alkaline suites (JANKOVIĆ, 1977, 1984), locally alkaline.

The principal genetic types of ore deposits are:

### 3.1. Porphyry copper deposits

The main features of porphyry copper deposits in the area under consideration can be briefly summerized as following:

Host intrusive rocks: The most common associated igneous rock types are quartz diorite, granodiorite and monzonite, and their porphyritic equivalents. The host intrusives are mostly composite, multistage and multiperiod complexes.

The differentiation sequences are calc-alkaline or calcic, locally slightly alkaline.

Age: The age of certain porphyry copper occurrences and host intrusions shows a general correspondance with the age of relevant tectonic events in development of the Tethyan domain.

Porphyry copper mineralization in the Tethyan Eurasian metallogenic belt was formed during several intervals: a) Upper Cretaceous-Lower Tertiary, b) Eocene-Oligocene, and c) Miocene. The Upper Cretaceous-Lower Tertiary deposits are dominant in Southeastern Europe, while the Tertiary deposits are mostly developed in Southwest Asia.

Alteration: Hydrothermal alteration of wall-rocks ranges from skarn in carbonate wall-rocks through potassic, sericitic to propylitic alteration of intrusive and extrusive igneous rocks. Biotitization, in some deposits, was found to be a good measure of intensity of chalcopyrite concentration (Sar Cheshmeh in Iran, Saindak in Pakistan). Intense silicification is a common characteristic of alteration, sometimes coupled with advanced argillic alteration in the uppermost parts of porphyry copper systems (Bor in Yugoslavia).

Alteration zoning is a characteristic feature of the alteration patterns. In some deposits argillic and advanced argillic alterations, as well as telescoping, were found. Pervasive pyritization often accompanies alteration.

Wall rocks: Copper mineralization is exceptionally developed entirely, or nearly so, in intrusive rock progenitors. Ore grade mineralization occurs both in the intrusive host rocks and in the sourrounding rocks.

Copper-bearing intrusions mostly invaded volcanic rocks (andesite prevails) and/or volcanic-sedimentary sequences; crystalline schists are seldom penetrated by the hypabissal intrusive host rock (the Medet deposit in Bulgaria – BOGDANOV, 1982).

Supergene effects: Oxidation and enrichment of some of the porphyry copper deposits (Sar Cheshmeh in Iran, Yulong in Tibet, China, etc.) have given rise to formation of thick enrichment blankets, but the enrichment zones have seldom little more than 20 m in thickness, and they are not of high grade; they are entirely lacking, particularly in some major porphyry copper deposits in SE Europe.

Related massive sulphide deposits: In some porphyry copper districts such as Recsk in Hungary (BAKSA et al., 1980), Bor in Yugoslavia (JANKOVIĆ ET AL., 1980) massive (pyrite) sulphide deposits, of volcanogenic replacement type in andesite, are in close genetic and spatial association with porphyry copper systems. These massive sulphide deposits were emplaced under advanced argillic conditions in a volcanic sequence, above the porphyry copper systems; they most probably represent the uppermost parts of the porphyry copper systems. SILLITOE (1973) considers advanced argillic alteration coupled with pervasive silicification as the common alteration type in the uppermost parts of a porphyry copper system, where volcanic rocks, comagmatic with the copper-bearing stocks, tend to predominate.

## 3.2. Skarn deposits

These deposits are mostly associated with calcic skarn, very seldom with magnesian skarn. They are usually of small size.

The skarn deposits most frequently involve the mineral associations shown at Table 2.

Table 2. Skarn deposits: Major mineral associations

| Mineral associations | Deposit |
|---|---|
| Magnetite ± Fe–Cu sulphides; with magnesian skarn: Ludwigite – magnetite | Ocna de Fier a. a. in western Romania – Ianovici and Borcos, 1982 |
| Scheelite ± cassiterite | SE Afghanistan (Abdulah and Chmyriov, 1980) |

Table 2. (Continued)

| Mineral associations | Deposit |
|---|---|
| Molibdenite – Bi-minerals | Baita Bihorului in western Romania (Ianovici and Borcos, 1982) |
| Chalopyrite ± pyrite, magnetite, galena, spalerite, locally scheelite as well | |
| Galena – sphalerite ± chalcopyrite | Rushita, western Romania (Kräutner, 1972*)) |
| Boron mineralization with magnesian skarns | Western Romania (Ivanovici and Borcos, 1982) |

*) from: IANOVICI and BORCOS, 1982.

### 3.3. Greisen deposits

The greisen mineralization is widespread in the ore fields of southeastern Afghanistan, where cassiterite is often accompanied by wolframite mineralization (ABDULAH and CHMYRIOV, 1980).

### 3.4. Volcanogenic hydrothermal deposits

These deposits are mainly associated with volcano-intrusive complexes of calc-alkaline suites. They are commonly located in subvolcanic level, genetically associated with deep-seated sources (hypabyssal intrusions). The country rocks are both volcanics and surrounding rocks. Mineralization is epigenetic with respect to volcanics, replacement type of mineralization occurs in places as well.

The spatial distribution of mineralization is often controlled by the volcanic structures.

Those deposits are usually characterized by a relatively short vertical interval of mineralization. The vertical zonation of mineral associations and ore metals is often found in some of these deposits (from top downward: gold → lead/zinc sulphides → copper sulphides). Telescoping of mineralization occurs occasionally, as well as grading into skarn mineralization.

Hydrothermal alteration is commonly widespread. The composition of the alteration facies depends on the composition of the country rock. Potassic, argillic alteration, as well as silicification, chloritization are the most widespread facies.

Among major deposits, belonging to this group, the following will be reviewed:

Copper massive sulphides: These deposits are associated with andesite-dacite volcanics. They are of replacement type and they are known mainly in SE Europe (Bor in Yugoslavia – JANKOVIĆ, 1982, JANKOVIĆ et al., 1980; Radtka, Krassen and Chelopech in Bulgaria – BOGDANOV, 1982). Gold is often a significant constituents of ore. Pyrite is usually the most abundant mineral, accompanied by many copper sulphides (chalcopyrite, enargite, covellite, chalcosite). Locally, native sulphur with copper sulphides was found.

Copper vein deposits in volcanics are rare, particularly those of economic importance (the Rossen ore field in Bulgaria – BOGDANOV, 1982).

Lead-zinc deposits: They are located along fractured zones in volcanics (andesite-dacite), less frequently in surrounding rocks, often in close connection with caldera structures.

The vein and replacement types are the most common, but stockwork and disseminated types occur as well.

Gold-silver deposits, vein and stockwork types, occur in subvolcanic level of andesite-dacite suites in the Carpathians (the Neogene Transylvania deposits such as Brad and Baia Mare in Romania – IANOVICI and BORCOS, 1982; Banska Stiavnica in Czechoslovakia – ILAVSKY et al., 1979).

Cassiterite deposits in subvolcanic level of andesite-dacite suites occur sporadically only. Some cassiterite stockwork mineralization in the Shindan-Kyshmaran district in Afghanistan (ABDULAH and CHMYRIOV, 1980) resembles porphyry tin type in the Andes.

It may be of interest to mention that cassiterite occurs in many sectors of the Tethyan Eurasian metallogenic belt, occasionally in or near copper deposits related to calc-alkaline complexes (the Bor district in Yugoslavia, the Chagai district in Pakistan, then around the Arghandab batholit in SE Afghanistan).

### 3.5. Volcano-sedimentary deposits

These deposits are associated with island arcs and andesite–dacite (± rhyolite) suites. Such deposits, both distal and proximal, contain copper and copper–lead–zinc sulphides; pyrite is as a rule the most abundant mineral. Barite occurs occasionally, as well.

In many metallogenic districts and/or within individual ore deposit such as those in the Eastern Pontids in Turkey, a lateral zonal distribution of ore metals was observed; in the Madneul copper deposit, Lesser Caucasus however a vertical one: zinc–lead sulphides ± barite dominate in the upper part of deposit, copper sulphides in the lower section of ore deposit.

## 4. Mineralization in continent-continent collision setting

Some of ore deposits in the Tethyan Eurasian metallogenic belt are associated with tectonic events after subduction of oceanic crust and the beginning of continent-continent collision.

The endogenous mineralization is commonly associated with granitoids emplaced in the overriding continental plate following continent-continent collision. Such granitoids derived predominantly from continental crust (S-type). Li, Sn and W are the dominant metals in mineralization generated in such a tectonic setting.

The Himalayas are probably the best example for a continent-continent collision in the Tethyan Eurasian metallogenic belt. Collision between the Indian and Eurasian plates, and renewed post-Eocene northwards motion of the Indian plate, resulted in crustal telescoping both north and south of the Indus-Tsangpo suture zone by means of deformation creep at depth and thrusting at higher crustal level (DEWEY and BURKE, 1973). This tectonic shortening and intracrustal thrusting in Oligocene and Miocene times can be considered as a mechanism for the Barrovian-type metamorphism and partial melting of deeper parts of the continental crust followed by intrusion of the leucogranites into higher levels (DIETRICH and GANSER, 1981).

So far known mineralization linked with anatectic granites in the Himalayas is not numerous. Tin, tungsten, locally fluorine, copper, antimony, lead-zinc are the most common, but large deposits have not been found. Greisen mineralization is rather frequent within marginal albitized, silicified, greisenised and/or tourmalinized facies of the leucogranites. Tin mineralization was reported by TALALOV (1976) for the margins of the Dandeldhura granite in the Lower Himalayas of West Nepal. The granite locally displays extensive greisen and cassiterite, scheelite and tantalo-columbite occur near the margin.

### 5. Post-collision*) magmatic activity and mineralization

Some regional metallogenic units such as ore districts and provinces in the SE Europe and the Asia Minor are associated with the Oligocene-Miocene calc-alkaline complexes. The origin of these magmatic complexes cannot be related to subduction of an oceanic crust and its partial melting, although they are situated in the vicinity of a suture zone, formed after the closure of the Vardar-Izmir-Ankara ocean. It is more likely, but still as a tentative model, that the widespread calc-alkaline igneous suites resulted from an anatectic partial melting of the lowermost part of continental crust and that locally even some ophiolites were involved. These processes took place during the late Palaeogene through early Neogene along the suture Vardar-Izmir-Ankara zone, preceeded by uplifting of the central parts of suture zone owing lateral compression.

The ore deposits were emplaced in hypabyssal and volcanic levels, later often associated with caldera structures. The ore deposits were formed from submarine brines, syngenetic and/or epigenetic with respect to country rocks; they represent a specific group of ore deposits developed in this tectonic setting. Some deposits were formed above ophiolites and they contain some elements which were mobilized by hydrothermal solution passing through ophiolites.

Lead-zinc and antimony are the dominant metals in this tectonic setting. The major ore deposits and the most significant associations of metals and minerals are the following:

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*) Collision of fragments of the former Afro-Arabian and the Eurasian plates.

5.1. Lead-zinc deposits: Skarn, volcanogenic vein and replacement deposits are the most common, characterized in places by significant vertical extent of mineralization (up to 2000 m such as in the Trepča deposit in Yugoslavia – JANKOVIĆ, 1967), Rodopi in Bulgaria, Laurion in Greece (Petrascheck and Marinos 1953).

Galena and sphalerite accompanied by pyrite, occasionally pyrrhotite, are the main minerals. Sulphosalts are often abundant. These deposits contain silver, particularly skarn type, gold and bismuth, as well as Cd, Ga, Sb as minor constituents of ore.

5.2. Antimony deposits: Numerous antimony deposits occur in the Serbian-Macedonian metallogenic province in SE Europe (JANKOVIĆ, 1960). Apart from almost monomineral stibnite deposits, there are other associations of metals and minerals such as Sb–As–Tl (Alshar in Yugoslavia; Gümüsköy in Turkey – JANKOVIĆ, 1982), Sb–W (stibnite-wolframite deposit at Philadelphion in Greece – JANKOVIĆ, 1979), Sb–Pb/Zn–As (Rujevats and Rajiceva Gora in Yugoslavia – JANKOVIĆ, 1979; JANKOVIĆ and ZARIC, 1980c).

A distinct zonation of Pb–Zn and Sb distribution occurs in some ore fields in Yugoslavia and Western Anatolia in Turkey.

5.3. Porphyry copper deposits occur occasionally mainly along a narrow fractured zone in the souteastern part of the SE Europe (the Buchim-Skouries zone – JANKOVIĆ, et al., 1980b).

5.4. Molybdenum mineralization is sparce. Some of them, such as the stockwork-disseminated low grade deposit at Machkatitsa in Yugoslavia (JANKOVIĆ, 1967; MILOVANOVIĆ and ILIC, 1953) can be very large.

The quartz-molybdenite veins are rather frequent, but commonly of small size (the veins in granite near Axiopolis in Greece – MARINOS, 1982), and the occurrences at Biga Penninsula in Turkey.

5.5. Hydrothermal sedimentary: These deposits were formed in the Neogene basins, originating from ascending hydrothermal springs and migrating through thin fractures into the basin of sedimentation. They supplied metal ions and caused a high-metal content in the water. This led to the depositional enrichment and formation of ore bodies. Such processes are commonly multi-cyclic.

The most significant mineral associations will be reviewed here:

- The large bedded magnesite such as bela Stena in Yugoslavia; some of these deposits contain increased concentrations of boron and boron minerals.
- The large bedded boron deposits, occasionally accompanied by As, are known in Western Turkey (EMET a. a.).
- the Sb–As–Tl deposit at Gümüsköy near Kütahya belongs to this type (JANKOVIĆ, 1982, JANKOVIĆ and BELL, 1976). The epigenetic quartz-stibnite veins occur in the basement of the sedimentary basin where Sb–As–Tl association was deposited.

– The complex Ag–Ba–Sb–As–Pb/Zn deposits at Gümüsköy was formed in the same Neogene basin as the Sb–As–Tl association.

Fig. 1 shows the distribution of major Alpine deposits and their relation with specific tectonic settings in the NE Mediterranean.

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