Chromitites in the Mirdita ophiolite (Albania): structure and genetic implications

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with 7 figures

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Contents

Abstract

In the Northern Mirdita ophiolite, the Western and the Eastern ultramafic massifs, respectively poor and rich in chromitites crop out. A cyclic functioning of a slow spreading system with magmatic and amagmatic episodes is supposed for the entire ophiolite domain. In the Eastern ophiolite belt, the Bulqiza and Tropoje diapirs are considered the most important chromitite-bearing areas. They represent favorable sites of an intensive magmatic activity. The scarce chromitites ores within the Western massifs would explain by a low magmatic activity to a spreading occur by tectonic extension along detachment faults (NICOLAS et al. 1999). Concerning the vertical distribution of chromitites through the Eastern massifs, the physical parameters as temperature and oxygen fugacity are regarded as the determinant factors. The most important chromitite deposits are located within depleted harzburgites, 500 m beneath harzburgite / transition zone boundary. The mantle cooling and the possible increase in oxygen fugacity favor the chromite and olivine crystallization from the rising melt. These features are characteristic for a thin oceanic crust, probably corresponding to the Eastern ultramafic massifs.

In the context of the structural classification, concordant, subconcordant and discordant chromitite ore bodies are evidenced. The relationships between ore body structures and ductile deformation structures of the surrounding peridotites are the main criterion distinguishing the structural type. The most important chromitite deposits are those of subconcordant and concordant type. In contrast, the discordant chromitites are of small size and have no economic interest. Meanwhile, they provide a valuable information because this structural type is attributed to represent the original site of chromitite ore body. The dynamic crystallization of chromititite ores occurred along the sub vertical conduits installed within harzburgites. Concordant and sub concordant ore bodies are inferred to be of the same origin as the discordant ones. The mantle ductile deformation caused the transposition of the ore bodies and their tectonic reorientation in conformity with the foliation and the lineation attitude. The concordant morphology is due to the high temperature deformations of the host peridotites. The lenticular form seems to correspond to the strong planar fabric, whereas the pencil-like pattern evokes a strong linear fabric of the wall peridotites.

1. Introduction

In 1980–s Albania ranked between the main world producers of podiform chromitites with provenience from ophiolitic complexes. So far, more than 28 million tons of chromitite ores are exploited. The production of chromite in Albania started at the beginning of the world second war, and in the eightieth the total chromite production reached the third place in the world. During the second half of the 20-century the chromite industry played an important role in the national income. Intensive geological studies, detailed mapping works and enormous volumes of the prospecting-exploration works have been carried out. Numerous projects and unpublished reports are an important scientific contribution showing the evolution of the geological ideas on the chromite ore deposits. According to CINA et al. 1986, SHALLO et al. 1989, the chromitites located within ultramafic tectonites are considered podiform ore bodies, whereas those ones found within ultramafic cumulates are inferred as stratiform. From the structural point of view, the chromities are considered to be in conformity with the host rock structures. The evolution of the ideas on the genesis of ophiolitic complexes has reflected on the concepts on the formation of chromite ores. Several magmatic impulses have been suggested, whereas the origin of ultramafic complexes, chromite ores, dunites and pyroxenites were related to magmatic-metasomatic processes (DEDE 1967). Based on the pluton-volcan hypothesis, the magmatic associations of Mirdita ophiolites are considered as the product of the differential crystallization of basic magma

Fig. 1: Geological setting of North-Mirdita ophiolite in the peri Alpine belts.Ophiolitic massifs in black. Area enlarged in figure 2 is indicated.

(NDOJAJ 1963). In that time, the majority of the authors have supposed the formation of the chromites through the gravitative crystallization.

The prospecting-exploration works of the chromite ore deposits provided an excellent information on their morphologic features. These data and the detailed structural mapping of mantle peridotites and chromitites of Mirdita ophiolites have been the main topic of the recent studies (MESHI 1996, MESHI et al. 1996, HOXHA & BOULLIER 1995, BOUDIER et al. 1997). In this paper, we are focused on the main geological-structural features of the chromite deposits, their structural classification and the mechanisms of their formation.

2. General Situation of Northern Mirdita Ophiolite

The Mirdita ophiolite represents the Western branch of the Dinaric ophiolitic belt (Fig. 1).

Emplaced during late Jurassic on continental margin, the ophiolite nape has been involved in the southwestward thrusting of Dinaric units during Eocene alpine tectonics; however, it is not affected by alpine events as marked by horizontal cretaceous deposits overlying the ophiolite. The Mirdita ophiolite extends on 250 x 40 km relayed to the south by the Pindos and Othrys ophiolites of the Hellenic belt.

The central part of the nape exposes a continuous oceanic crust including a reduced gabbroic section, an N-S and poorly organized sheeted complex and above, tholeiitic extrusive. Its age of origin is known through U/Pb radiogenic dates of 162+22 Ma on apatite from plagiogranites intruding the lowermost basaltic lavas (IVANAJ 1992) providing a minimum age for the oceanic crust. Radiolarian dating (MARCUCCI et al. 1994) supports an Upper Bajocian-Lower Callovian age (170-160 Ma) for faunas associated with the lower basaltic lavas and a middle Callovian-Upper Oxfordian (160-150 Ma) age for faunas associated with dacitic flows. Mirdita nape thickens eastward with an N-S synform structure. Peridotite massifs extend along two lateral eastern and western belts, and a discontinuous metamorphic sole marks out both limits. $^{40}Ar/^{39}Ar$ age determinations for the amphibolites from the high grade metamorphic sole date the intra-oceanic event related to ophiolite detachment (VERGELY et al. 1998). They suggest an age difference between detachment of the south (170-174 Ma) and the north (162 Ma) of Mirdita unit.

The petro-structural study emphasizes the differences

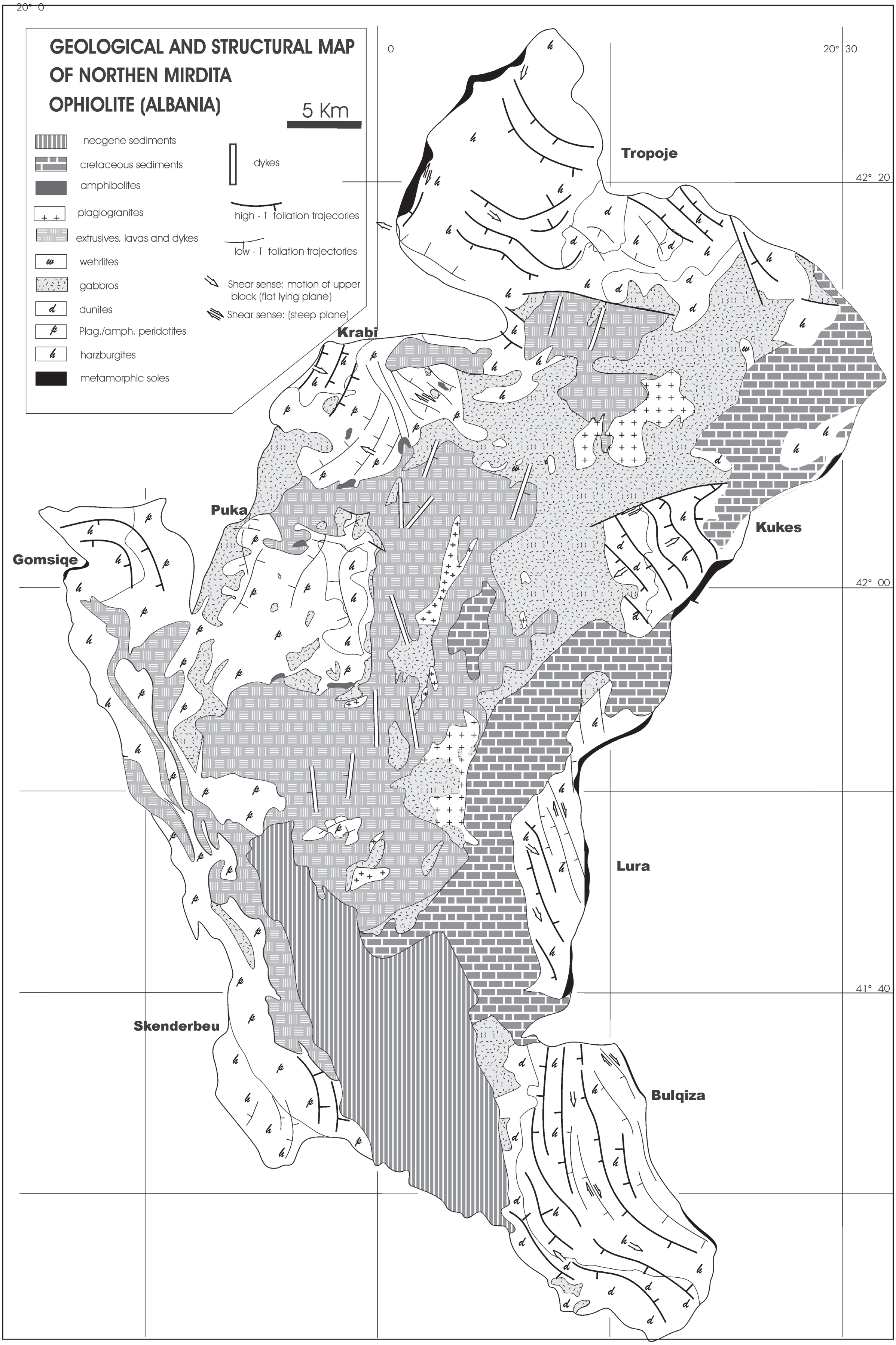


Fig. 2: Geological and structural map of the Mirdita ophiolite.

between the eastern and western parts of the nape. The detailed structural mapping of the western massifs revealed that the plagioclase peridotite development is associated with highly deformed to mylonitic facies. It is visible in the field that, in these mylonites, the clinopyroxene and plagioclase has been introduced by tectonic dispersion of gabbroic dikes and melts impregnation patches. Outside these intensely deformed areas, the peridotite is a clinopyroxene-bearing harzburgite. The melt impregnation and the low-T intense deformation are associated with and affect mainly the upper levels of the massifs, close to the contact with crustal units. It is concluded (NICOLAS et al. 1999) that western massifs are basically harzburgitic like the eastern massifs, but with local development of plagioclase lherzolites by melt impregnation with concomitant and/or subsequent large plastic deformation at comparatively low temperatures. The eastern massifs (Bulqize, Lure, Kukes and Tropoje) (Fig. 2) have a harzburgitic mantle section, including large chromite deposits located below the Moho.

They exhibit a thick (1 to 2 km) dunitic zone. Numerous dikes which are pyroxenitic in the lower section and gabbroic in the upper section cross - cut the mantle section. The high-T foliations show moderate dipping to the southwest in Tropoje and Kukes, with lineation orienting to down-the-dip. The sense of shear consistent in the Kukes massif suggests that the paleoridge of origin was to the west (HOXHA & BOULLIER 1995). In Lura and Bulqiza massifs high-T foliation low moderate to steep dipping towards the west, with lineation generally horizontal (NICOLAS et al. 1999). The sense of shear is dominantly sinistral (Fig. 2). The dip of foliation in these massifs suggests a paleo-ridge to the east. The crustal rocks of the Mirdita ophiolite are extremely heterogeneous. The contrast between the „normal“ ophiolitic sequence on top of the eastern Tropoje massif and around the Kukes massif and the reduced section covering the western Krabi and Puka massifs is discussed (NICOLAS et al. 1999). The Kukes massif (HOXHA & BOULLIER 1995) displays a typical lower crust composed of layered olivine-gabbros and norites. The layered gabbros grade up section into foliated and isotropic hydrothermaly altered amphibole gabbros and into a sheeted dike complex with basalt, keratophyre and plagiogranite dikes. The extrusive section is well developed, consisting of basalt to basalt-andesite lavas and pillow lavas, overlain by rhyodacite and boninite extrusive. The plutonic part of the crustal sequence is intruded by wehrlite and plagioclase-wehrlite bodies, and quartz-diorites and plagiogranites constituting large massifs (Fig. 2). The crustal rocks of the western massifs are markedly different. Gabbros, ranging from troctolites to leucogabbros, ferrogabbros and kaersantite gabbros, have undergone limited extension and are strongly plastically deformed, becoming isoclinally folded flasergabbros near the Moho. The sheeted dike complex seems to be variously developed and the rapid transition from isotropic gabbros and plagiogranites to pillow lavas suggests that this complex is locally reduced. Gabbros can be totally absent.

These differences are interpreted (NICOLAS et al. 1999) as recording in the western domain a tectonic type of expansion by normal faulting, resulting in mantle denudation, versus a magmatic type of expansion in the Eastern domain producing a continuous oceanic crustal section. MESHI et al. (2004) have described the Mirdita ophiolite originated from a right-lateral motion between Korab-Pelagonian and Apulia microplates, opening a pull-apart basin characterized by dual spreading axes. SHALLO & DILEK (2003) suggest a subduction zone setting for the eastern-type ophiolite.

3. Chromitites of the Northern Mirdita Ophiolite

The largest chromite concentrations of the Northern Mirdita ophiolite belong to the ultramafic massifs of the Eastern belt. So, in Bulqiza massif are known about 174 chromite deposits and occurrences, in Kukesi massif about 85, in Tropoja massif about 300 and in Lura massif 16. In the Eastern belt, the most important chromite-bearing massifs are those of Bulqiza and Tropoja, where Bulqiza diapir (MESHI 1996) and Kepeneku diapir in Tropoja massif were mapped.

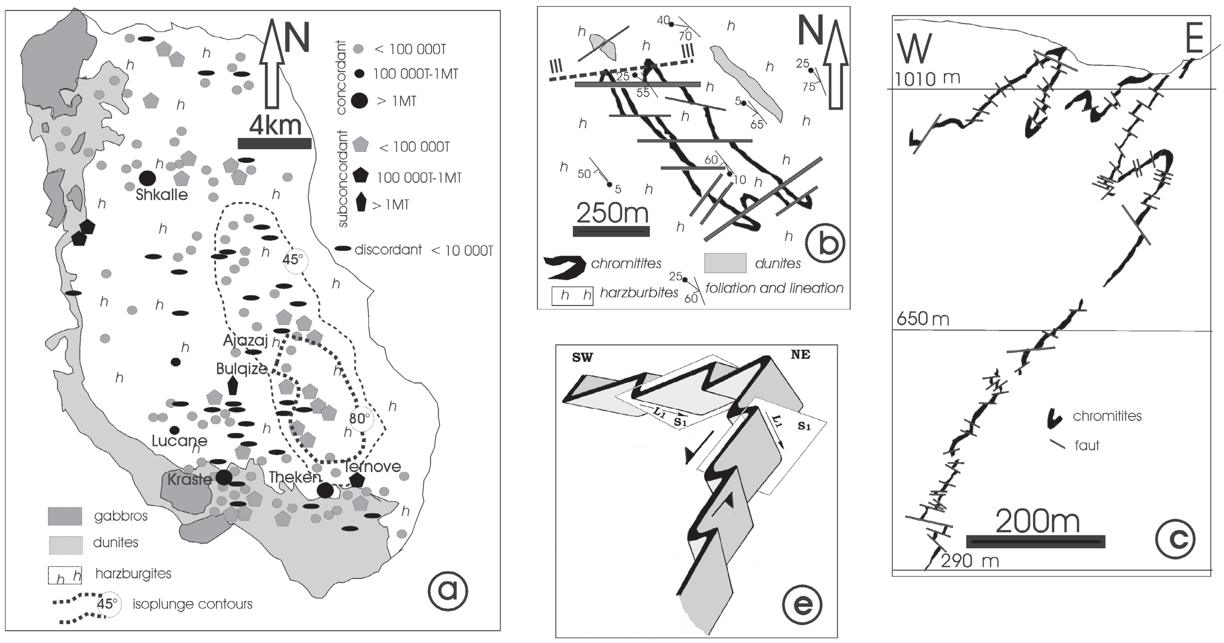
The Moho boundary between mantle peridotite and oceanic crust is a horizontal paleoplane considered as reference to vertical distribution of chromite pods (LEBLANC & NICOLAS 1992). In the ultrabasic massifs of the Eastern belt, the most important chromitites are located at the section up to 1,5 km below paleoMoho, but rare and small chromite bodies are found up to 3 km below the paleoMoho (Bulqiza and Kukes massifs). The biggest and highest-grade ore bodies, which constitute about 90 % of the total reserves of Albanian chromites, are located within depleted harzburgites, 500 m below the harzburgite/transition zone boundary. The best examples are those of Bulqiza, Shkalla, Ternove, Theken, Lugu i Qershise ore deposits from Bulqiza massif; Kalimash 2, Kalimash 3, Surroj ore deposits from Kukesi massif; Vlahen, Kepenek, Zogaj, Lajthize, Rragam, Qafe Prush, Tpla ore deposits from Tropoja massif. Rarely and smaller in size are chromite deposits found within transition zone (Krasta deposit in Bulqiza massif; Kalimash 1 deposit in Kukesi massif; Gzhime and Maç deposits in Tropoja massif). The mantle section of the Eastern massifs, favorable for the chromite concentrations is partly exposed in Lura massif. Its largest part is covered by carbonate deposits of Cretaceous.

In the Western ultrabasic massifs, few chromite showings, small in size and generally uneconomic are located within mantle harzburgite. They are developed about 500 m below the plagioclase peridotite.

3.1. Bulqiza massif

The mantle section of Bulqiza massif (Fig. 3) is composed of clinopyroxene harzburgite grading up section into depleted harzburgite with dunite bodies and to the transition zone (massive dunite, dunite and plagioclase impregnated harzburgite, wehrlite, lherzolite and clinopyroxenite).

The thickness of the peridotite is estimated about 5 km and about 70 % of the massif is constituted of the depleted harzburgites and the transition zone. In the last ones, the majority of the chromite deposits are recognized. Small chromite occurrences, around 3 km beneath the paleoMoho



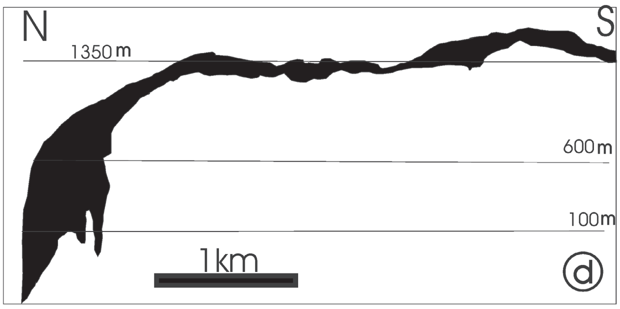


Fig. 3: Distribution of chromite ore bodies and structural types of chromites in the Bulqiza massif. b) Geological map of the Bulqiza ore deposit. c) Cross-section III-III in the Bulqiza ore deposit. d) Longitudinal section of the Bulqiza ore deposit. e) the geometrical relations of the folding in the Bulqiza ore deposits with the foliation-lineation of surrounding peridotites. Duble arrow indicate sense of shear in high-T harzburgites.

boundary are found. Recently, a vertical mantle diapiric uprise is mapped out. Around and the far way from the diapiric structure, the mantle flow planes show a moderate dipping towards the west, whereas the flow lineation in these planes are sub horizontal. About 90 % of the total discovered chromite in Albania belongs to this massif. The most typical chromite deposits display interesting geolo-gical-structural features.

Bulqiza ore deposit (Fig. 3b, c, d, and e). It is located within clinopyroxene harzburgite (the deepest parts) and within depleted harzburgites developed near the transition zone (the uppermost parts). A thin dunite envelope, several cm up to 3 m thick is generally found around the ore bodies, but locally the chromitites show a sharp contact with the wall harzburgites. The thickness of ore bodies varies from 1 up to 10 m, whereas the average content of Cr_20_3 is over 40 %. Concerning the size and morphology of the ore bodies, Bulqiza deposit is one of the most outstanding example in all the alpine ophiolites. About 23 million tons of high-gra-de chromite ore are discovered, from which about 16 million tons are mined out. The Bulqiza deposit occupies an area about 5 km long and 1.5 km wide. It was considered as a single ore body (SHALLO et al. 1989), but the recent studies, making use of the prospecting-exploration and mining data reveal the development of several ore bodies. The ore body shape is characterized of tight isoclinals folds, where the thickest parts belong to their apexes. Bulqiza chromite deposit is an excellent case of the subconcordant type, where the long flanks of the isoclinals folds are parallel to the foliation of the host periodites, whereas the short ones are discordant to them (Fig. 3e). The isoclinal folding axis is aligned parallel to lineation of peridotites. The axial plane of isoclinal folds dips approximately 60° southwestward. Upward it changes and dipping becomes 35° towards the southwest.

This structural attitude is in concordance with foliation of the surrounding peridotite (MESHI 1996, MESHI et al. 1996). At its deepest parts, the ore body plunges towards NNW with 50-70°, while in the central part it becomes sub hori-zontal and gradually it rotates towards SSE reaching 20° at its southernmost extremity. The structural attitude of the ore body is concordant with lineation of the surrounding peridotite. Many geologists have interpreted the structure of Bulqiza chromite deposit as an asymmetric antiform mega structure, gently overturned towards E, which later is complicated by the second order folding

Thekna ore deposit. So far, around 1.5 million tons of chromite ores are discovered. From the total reserves, 0.9 million tons are already mined out. It is located within depleted harzburgite with dunite lenses 10-50 m thick. This ore deposit is constituted of several bodies. The main one is situated within a dunite lenses about 30 m thick. Dis-

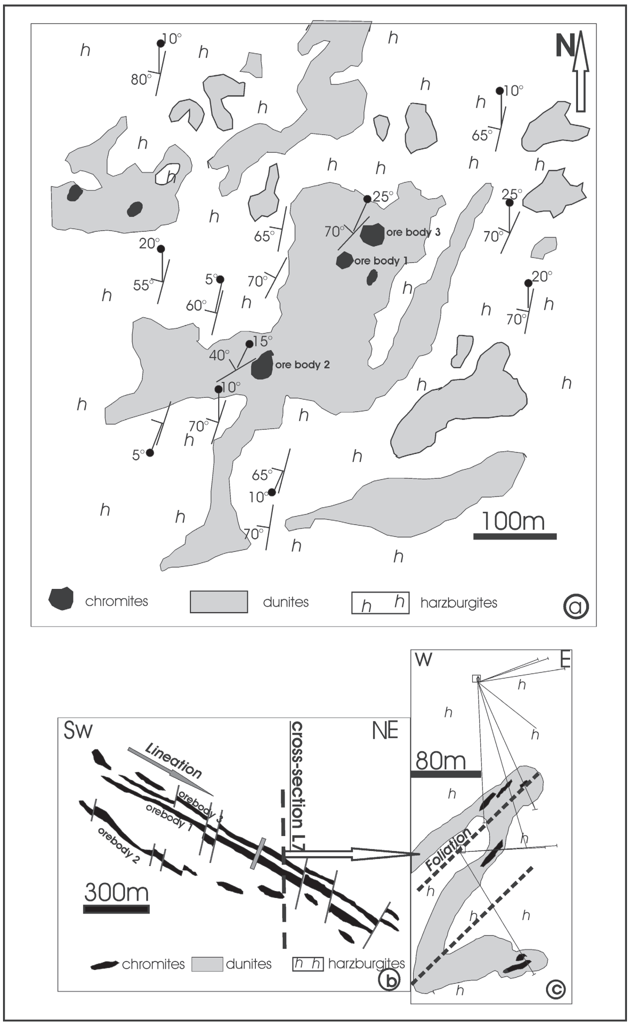


Fig. 4: a) Geological map of the Shkalla ore deposit (Bulqiza massif). b) Longitudinal section of the Shkalla ore deposit. c) cross-section L7 in the Shkalla.

seminated and massive are the predominate textures of ores, but locally layered and nodular textures occur as well. At the deepest parts of the section, the ore body is of pencil-like morphology and plunges with 40-50° ESE, whereas at the upper parts, near dunites of the transition zone, it is lens - shaped. The flattened side of the ore body is parallel to the foliation of the surrounding peridotites, whereas its plunging is in concordance with lineation of the surrounding peridotites.

Shkalla ore deposit. From the morphologic point of view, the typical pencil - like shape of this deposit makes it very specific and original. Three ore bodies constitute the deposit (Fig. 4)

Ore bodies No. 1 and 3 are developed 1600 m in strike, while the thickness ranges from 2 up to 10 m. The surface of the ore body in the cross-section varies between 80-400 m^2. Ore body No. 2 is followed about 900 m in strike. The thickness is 1.5-3 m, while the surface of the ore body in the cross-section ranges between 50-100 m^2 (Bushi & Jauri 1996). It is located within harzburgites with a dunite envelope 15-40 m thick. So far, about 1, 3 million tons ore grading 30-44 % $Cr_2 0_3$ are discovered, while 1, 2 million tons already are mined out. Ore bodies No. 1 and 3 show flattened pencil shape. The flattenend side is in concordance with foliation plane of the surrounding peridotite, while the plunging of the ore body is parallel to lineation. Ore body No. 2 is constituted of several small pods elongated towards the plunging, where their axes are parallel to the lineation of the surrounding peridotite. The changing of the transversal section size is caused by the boudinage occurring during the high temperature ductile deformation. The wall dunite shows isoclinal folds, where their axial plane is parallel to the foliation (Fig. 4c).

Krasta ore deposit. So far are discovered about 0.8 million tons ore, from which 0, 5 million tons are already mined out. Chromite ore bodies are located within dunites of the transition zone Moho. Banded ore textures are dominant, but nodular and massive ones are also present. The ore bodies which are gently flattened and strongly elongated, being parallel to the strong lineation in dunite (Meshi 1996, Meshi et al. 1996). The prospecting-exploration geologists considered that the ore bodies are situated within an intensively folded zone. They are interpreted as the flanks of the open gentle fold, dipping in West and in the East. According to Shallo et al. (1989), the ore body is located within cumulative dunites, which are discordant to mantle harzburgite. Recent studies (Meshi 1996) documented no structural discordance between mantle harzburgite and massive dunite.

3.2. Kukesi massif

Kukesi massif (Fig. 5) is composed mainly of mantle harzburgites with rare and small dunite lenses.

Upwards, the section grades into depleted harzburgites with abundant dunite bodies, most of which are up to 200 m thick. The transition zone is characterized of massive dunites with harzburgite lenses. Close to the contact with layered gabbros, clinopyroxene impregnated dunites and wehrlite bodies are developed. Numerous pyroxene dikes, several cm up to 50 m thick are present in the upper part of transition zone. Kukesi ultramafic massif belongs to the eastern flank of the oceanic ridge (Hoxha & Boullier 1995). The main chromite concentrations are within depleted harzburgites with thick dunite lenses and within massive dunites of the transition zone. Although, chromite bodies within mantle harzburgite up to 3 km below ultramafic-gabbros limit are found as well.

Kalimash 1 ore deposit. It is located within dunites of the transition zone. Several ore bodies are discovered, but the most important of them are the ore bodies No. 7 and No. 10. Ore body No. 7 is lens-shaped and flattened towards the sub horizontal foliation plane. The ore body attends 800 m in strike, 600 m in dip and thickness varies 0.5-6.4 m. The average grade of ore is 20 % Cr_2O_3. Up to now, 1.3 million ton reserves are discovered. The layered texture is characteristic for this ore body. Ore body No. 10 shows lens-shape too, the flattened side of which is parallel to the foliation in dunites. The ore body extends 340 m in strike, 300 m in dip and thickness varies 0.7-2.5 m. So far, about 0.5 million ton ore averagely grading 28 % $Cr_2 0_3$ are discovered, from which 0.4 million tons are already mined out.

In mantle harzburgites, cropping out in SE part of the massif,

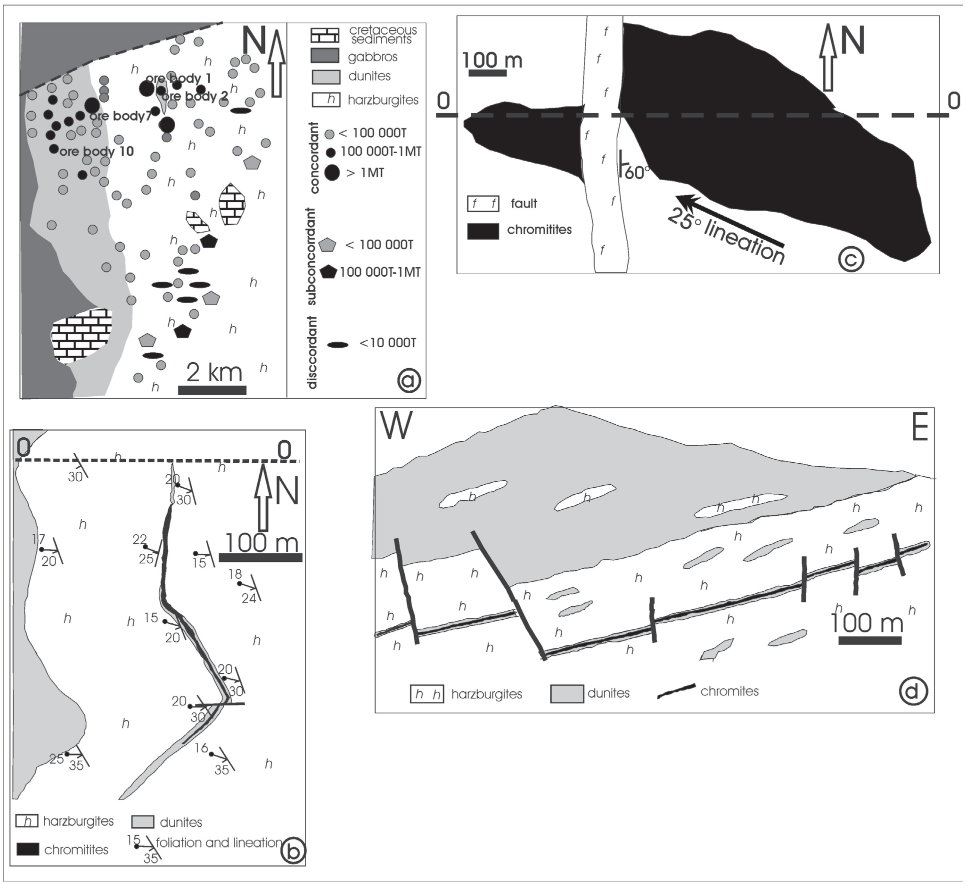


Fig. 5: a) Distrubution of chromite ore bodies and structural types of chromites in the Kukesi massif. b) Geological map of the No. 1 ore body (Kalimash 2 ore deposits). c) Cross-section 0-0 in the ore body No. 1. d) Longitudinal section of the ore body No. 1.

small chromite occurrences are found. They are of high grade (over 42 % Cr_2O_3). The principal textures are massive and nodular. The pencil-lake morphology is characteristic. Their axis are parallel to the lineation of the harzburgite. Along the plunging, is documented the variation of the cross section surface (ellipsoid-shaped).

Kalimashi 2 ore deposit. It is located within depleted harzburgites with thick dunite lenses. Several bodies are discovered, but the most important are the ore bodies No. 1 and 2. Ore body No. 1 (Fig. 5 b, c, d) is located within harzburgite with a thin dunite envelope, several cm up to 2 m thick. Sometimes the wall dunites are absent. Texture is dense disseminated and locally massive. About 1.3 million ton ore with average grading 35 % Cr_2O_3 were discovered, from which 0.8 million ton are already mined out. The ore body is typical lens-shaped, where the flattened side is parallel to the sub horizontal foliation in harzburgite. The ore body extends 1700 m in strike, 500 m in dip and thickness varies 0.5-3 m. The maximum development (length) corresponds to the lineation strike in harzburgite. Ore body No. 2,“ stratigrafically“ lie under the ore body No. 1. It occurs within dunite lens 200 m thick. The banded ores texture with abundant small scale isoclinals folds (several cm up to 20 cm) is typical for this ore body. About 0.8 million ton ore grading 20 % Cr_20_3 are discovered, from which 0.5 million ton are exploited. The ore body is lens-shaped and developed 500 m in strike, 300 m in dip and 0.3-4 m thick. Sub horizontal axial planes of isoclinals folds are parallel to the foliation, whereas their axis are parallel to high-temperature lineation of the surrounding peridotite.

3.3. Tropoja massif

In the whole Tropoja massif (Fig. 6) about 10.4 million tons chromite ore are discovered.

From this total, 1.7 million tons are already exploited. Tropoja ultramafic massif is constituted of mantle harzburgites with dunite lenses, followed by the Moho transition zone (dunite, wehrlite, plagioclase peridotite, lherzolite etc.). The pegmatite pyroxenites are considered ultramafic cumulates (MEKSHIQI 1996), but in reality they represent a typical swarm of pyroxenite dikes developed in the upper part of the transition zone (NICOLAS & BOUDIER personal communication). The main chromite concentrations are related to the diapiric structure (Meshi, unpublished data).

Vlahna ore deposit (Fig. 6). 2.5 ton chromite ore are discovered, but about 0.2 million ton are already mined out. It is located within depleted harzburgite with abundant and thick dunite lenses. Vertical projection (fig. 6c) shows three ore bodies plunging 25° towards N. The plunging of ore bodies is parallel to the lineation of the host dunites and harzburgites. Ore body No. 1 shows sub pencil-like shape. It is 1100 m in strike, 220 m in dip and 0.5 m - 12 m thick. The ore grade vary from 18 to 43 % Cr_2O_3. Ore body No. 2 of lens-shaped is 600 m long, 300 m wide and 0.5 m-11.8 m thick. The ore grade ranges between 18 and 37 % Cr_2O_3. Ore body No. 3 demonstrates a lens shape, 450 m in strike, 220 m in dip and 0.3 to 8 m thick. The average grade of the ore is 30 % Cr_2O_3. Ore bodies show isoclinals folds, which are thicker and richer at their fold apexes. Axial planes and axis of isoclinal folds are parallel to the foliation and lineation of

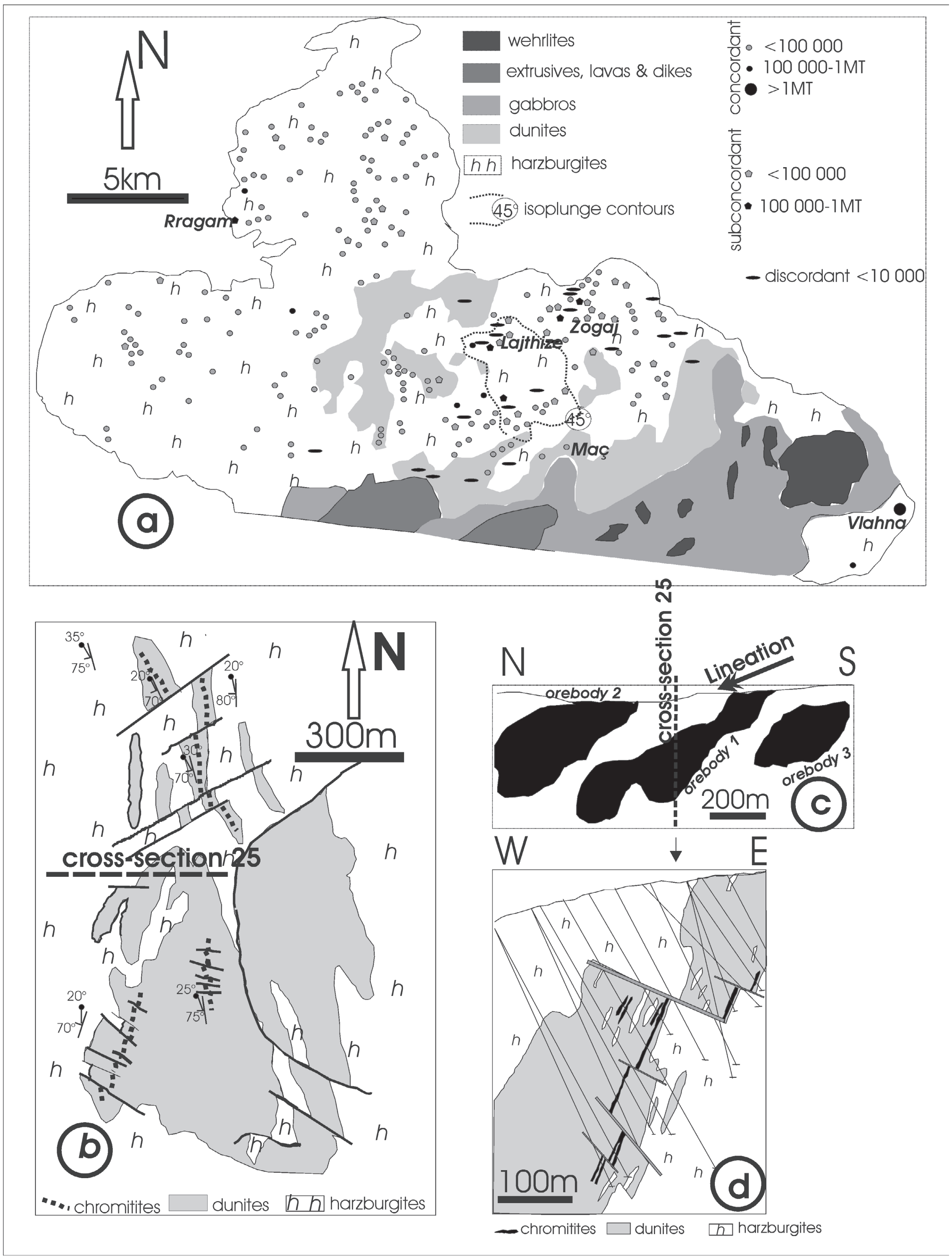


Fig. 6: a) Distrubution of chromite ore bodies and structural types of chromites in the Tropoja massif. b) Geological map of the Vlahna ore deposits. c) Cross-section 25-25 in the Vlahna ore deposit. d) Longitudinal section of the Vlahna ore deposits.

the surrounding peridotites. Medium up to dense disseminated textures are the dominant, but nodular and banded ones are present as well.

Maja e Lajthise ore deposit (ore body No. 2). The ore body is located within depleted harzburgite, representing the topmost part of the diapiric structure (Meshi, unpublished data). Ore body is flattened pencil-like shaped, 160 m in strike, 60 m in dip, and 4 m thick. The plunging of ore body is parallel to the sub vertical lineation of harzburgites. Massive texture of ores are mostly developed, but locally nodular one occurs also. Up to now are discovered and mined out about 0.2 million ton chromite grading on average 47.2 % Cr_2O_3.

Zogaj 3 ore deposit. It is located within depleted harzburgite with dunite lenses. This deposit occurs in the periphery of the Tropoja diapir. About 0.75 million ton ore with average grading 27 % Cr_2O_3 are discovered. The banded texture predominates, but nodular one is also present. Locally, small-scale isoclinals fold are observed. Their axial planes and folding axis are respectively parallel to foliation and lineation of the surrounding peridotite.

Rragam ore deposit (bodies No. 1 and No. 2). About 0.75 million ton ores, with average grading 35 % Cr_2O_3, are discovered. Ore body No. 1 is related to a thick dunite lens within harzburgites. It is flattened lens-shaped. The size is 345 x 200 x 0.5 - 13 m. The flattening side of the ore body is parallel to the foliation, while the elongation is in conformity with the peridotite lineation. Ore body No. 2 is located within harzburgite and is enveloped with dunites 5-10 m thick. It is flattened pencil-like shaped and shows 45° plunging towards northeast being parallel to the lineation of the harzburgites. The ore body extends 400 m in strike and 60 m in dip. The disseminated and nodular textures are characteristic.

3.4. Lura massif

Lura ultramafic massif (Fig. 2) is composed of clinopyroxene harzburgites. The clinopyroxene amount ranges 2-5 %. About 16 chromite occurrences of this massif are located within less depleted harzburgite. The podiform chromite ore bodies are of small size. Normally they are flattened after the sub vertical foliation and elongated parallel to the sub horizontal lineation of harzburgites. The striking of ore bodies is 5° N. Ore bodies exhibit massive, nodular and rarely antinodular textures.

3.5. Massifs of western ultrabasic belt

In the western ultrabasic massifs (Fig. 2), only small size chromite occurrences, generally uneconomic are evidenced. They are located within depleted mantle harzburgites, close to the contact with plagioclase peridotites. Plagioclase and hornblende peridotites are largely developed, occupying over 70 % of the massifs surface (Fig. 2). To the last ones, only two chromite showings are discovered (Puka massif).

4. Internal Structures

Podiform chromite deposits display both magmatic and deformation textures (THAYER 1969). Magmatic structures (nodular and orbicular) occur in many chromites of the Northern Mirdita ophiolite (Fig. 7).

Undeformed nodules (Fig.7i) or nodules showing magmatic flow fabric (Fig.7a) are frequently observed at the center of the chromite ores. Disseminated and schliere chromites, normally found at the periphery of ore bodies show ductile deformation structures. In the Bulqiza ore deposit of the subconcordant type, many centimetric chromite lenses indicate the magmatic textures, meanwhile at their periphery, ductile deformation structures are developed. Nodules are interpreted as an agglomeration of chromite crystals by magmatic flux (JOHNSTON 1936, THAYER 1969, LAGO et al. 1982). Another mechanism suggesting the formation of several polyedric nodules (rhombic in section) by skeleton growth of chromite monocrystals is proposed as well (LEBLANC 1980, LEBLANC & CEULENEER 1992). Chromite occurrence of Mac (Tropoja massif) exhibits orbicular texture (Fig. 7k). Orbicules show magmatic structures but often they show ductile deformation features (elongation of orbicules is perpendicular to pull-apart textures). Chromite bodies are formed either in magmatic micro chambers of upper mantle (BROWN 1980) or to sub vertical magmatic channels below the accretion zone (JUTEAU 1975). Orbicules are considered as concretions with successive chromite coating formed in a very fast magmatic flux, which may hold in the suspension the orbicules (LEBLANC et al., 1981).

In the discordant ore bodies, the primary magmatic structures are dominant. The irregular disseminations and schlieren with heterogeneous magmatic textures are evidenced. They are similar to „chromite net textures“ or „occluded silicate texture“ described for the chromite bodies found in the Stillwater stratiform magmatic complex (JACKSON 1961, THAYER 1969). The irregular net ore textures close to the dikes and pellets of dunitic fragments in a chromite-olivine-pyroxene matrix (olivine occluded texture) seems to support the suggestion on the interaction of a magmatic impregnation of country rocks starting from dikes (CEULENEER & NICOLAS 1985). Massive texture with coarse cubic crystals 5-7 mm in size is evidenced in discordant chromite within an intrusive pyroxenite lens, which is itself discordant to host rocks. The cubic crystals of very regular planes and no curved figures are observed. In contrast, massive texture with coarse-grain regular crystals with curved planes are often observed in chromite of concordant and subconcordant types. This may correspond either to a magmatic structure or late magmatic preserved by deformations (LEBLANC & NICOLAS 1992). After CHRISTANSIEN (1986) this structure type is product of the baking in high temperature at the end of plastic deformation.

Deformation structures show the flattening in the foliation plane and elongation of the nodules, antinodules, orbicules, grains and schlierens of chromite. Generally, they are parallel to the lineation. In massive texture chromites the pull-apart plane is perpendicular to the foliation and the lineation. These structures are most spectacular in chromites of Northern Mirdita ophiolite. In the massive chromites, elongated nodules are perpendicular to the pull-apart plane, which is evidenced in the chromite matrix. This plane is perpendicular to a dunite vein crosscutting chromite (Fig. 7c). In periphery of a massive ore, the chromite nodules (Fig. 7h) show figures of intensive ductile deformation (fractures of the extensional regime perpendicular to the lineation of elongation nodules). Progressive extinction of the magmatic textures is due to the intensive ductile deformation. At periphery of a nodular chromite (Fig. 7d), nodular texture is almost homogenous and rather difficult to observe. Toward the nodule center where deformation is more intensive it is easily observed. Such picture is not present all the time, because it depends from the density of nodules. In the nodular chromites of Lura massif, although nodules are highly deformed (elongation ratio is up to 10 and the pull-apart textures are largely developed) the nodular texture remains still apparent. So, the intensive deformation figures imprinted at nodules are depended from their volume with respect to the silicate matrix. This phenomenon is due to the chromite attitude as an inert element within a ductile matrix (SECHER 1981, CASSARD et al. 1981). During the deformations, the size of nodules practically reflects their attitude. Nodules of small size (Fig. 7e) are more deformed compared to those bigger in size. At the same time, the deformation structures could be evidenced also in the dunites, pyroxenites and gabbroic veins cross - cut ore bodies. In reality, they represent extensional fractures of centimetric up to decimetric size (Fig. 7l). These structures are characteristic for concordant bodies and statistically their planes are perpendicular to the long axis of the ore body. Antinodular textures (Fig. 7g) occur at many concordant chromite bodies. They show deformation figures with an accentuated elongation. It is difficult to distinguish if they are as result of dunite lenses deformation within chromite or by ductile deformation of the chromite originally brecciaed (LEBLANC & NICOLAS 1992). It is probable that antinodular textures observed at periphery of concordant

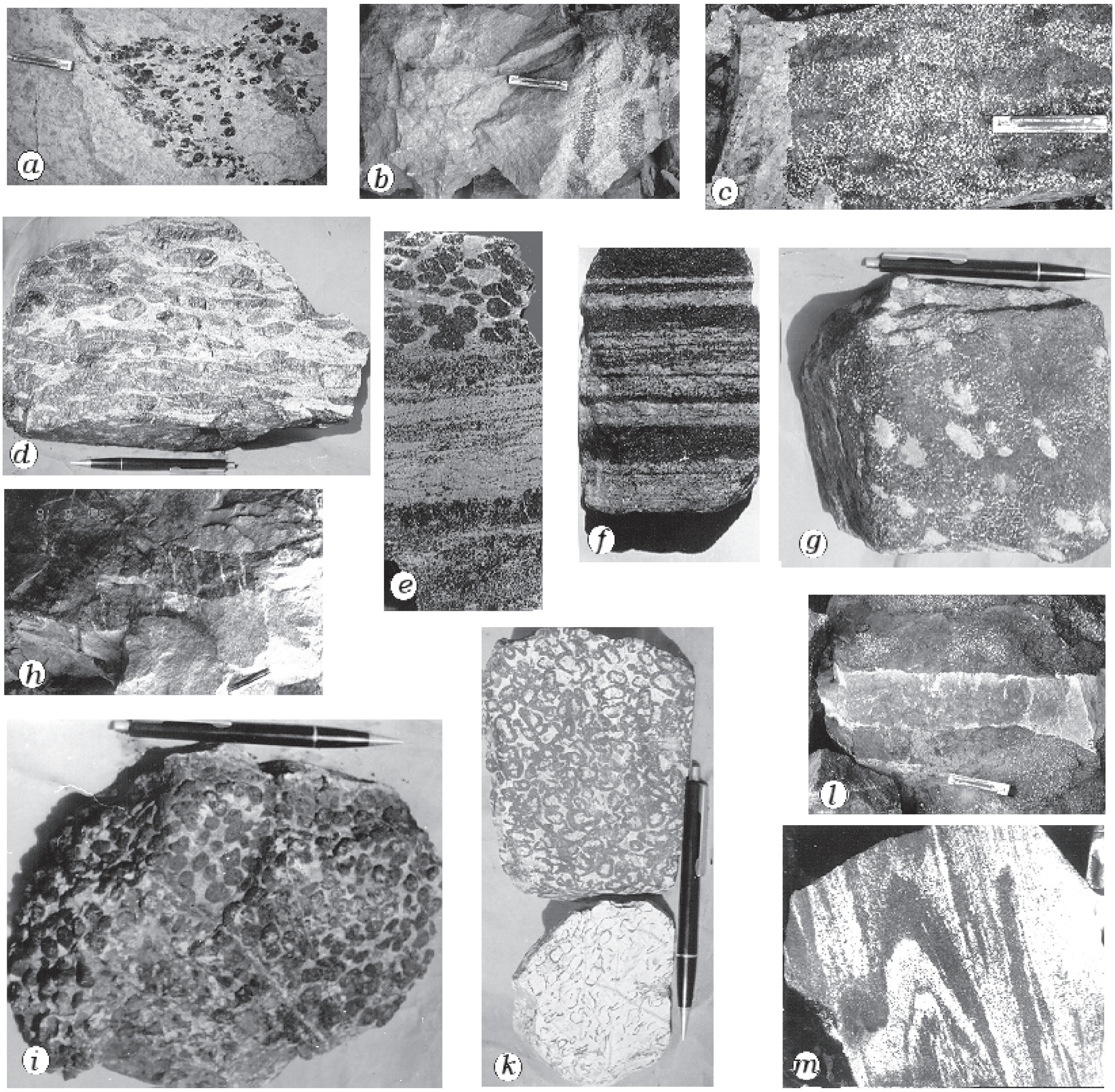


Fig. 7: Chromitite textures of Northen Mirdita Ophiolite. a) Nodular texture with figures of magmatic flow. b) Nodular chromite showing relationship gangue dunite with residual dunite/harzburgite. c) Nodules of massive chromite with a disseminated chromite matrix. Elongations of nodules are parallel to lineation and perpendicular to a dunite vein cross-cuting chromite. d) Nodular chromite intensively deformed mainly at margins. e) Banding of chromites chlieres intensively deformed and nodular chromite. Small size nodules are more deformed as compared to big ones. f) Banding chromite showing boundinage figures. g) Antinodular texture chromite. h) Chromite nodule displaying pull-apart fractures perpendicular to lineation. i) Nodular chromite with magmatic structure. k) Orbicular texture chromite. Orbicules often display figures of plastic deformation. l) Dunite vein cross-carting chromite ore body. m) Isoclinal folds of decimetric range in banding chromite).

or subconcordant chromite have originated by brecciaed elements of dunite.

Banded textures (Fig. 7e, f) are interpreted of the stratification origin in cumulative dunite located over harzburgite (Cina et al. 1986, Shallo et al. 1989). Structural evidences reveal that banded chromite is characteristic of concordant ore bodies developed within dunites of the transition zone or within large dunite bodies in the harzburgites. So, in the Kuksi massif (distinguished for abundant presence of banded chromite) ore body No. 2 with layered texture found within a dunite lens 200 m thick is „*stratigrafically*“ located about 200 m below ore body No. 1. The last one located within harzburgite exhibits dense dissemination up to massive texture. Only a thin dunite envelope up to maximum 3 m thick is rarely present. In Bulqiza massif, two chromite occurrences of concordant type, 30 m far from each other are located within harzburgite. One of them, massive in texture, is in direct contact with harzburgites, whereas the other, banded in texture is located within a dunite lens 20 m thick. In the most cases, the structures of banded chromite show a clear ductile deformation (Fig. 7e). The spectacular evidence of this kind of deformation is the discontinuous decimetric isoclinal fold (Fig. 7m). Symmetric layering doesn't support their sequential evolution, which is characteristic for stratiform bodies. This symmetry argues the dynamic magmatic crystallization, which is more characteristic for the discordant ore bodies (CASSARD et al. 1981).

AUGE (1988) discussed in detail the hypothesis of the dunite origin in ophiolitic complexes. Two distinguished groups can be considered: remnant origin of pyroxene peridotite transformation (harzburgite or lherzolite) and olivine-chromite accumulation formed by magma fractionation crystallization. Structural evidences of chromitites located in the dunitic lenses within harzburgites of Northern Mirdita support the idea for the presence of two dunite types, the magmatic and residual one (Fig. 7b).

5. Structural Types of Chromite

Structural classification of the chromite bodies (CASARD et al. 1981) is based on the shape of chromite pods form and their relationship to the ductile deformation structures of the surrounding peridotite (foliation, lineation). Structural maps of Bulqiza massif (SHALLO et al. 1989), Kukesi massif (SHEHU et al. 1989), Lura massif (LLAVESHI 1996) and Tropoja massif (MEKSHIQI 1996) supply data on the chromite/peridotite contact and the structures of the different magmatic rocks. This information is important, but not sufficient for the structural characterization of chromite bodies. The classification of the ore bodies as concordant, subconcordant and discordant (DOBI et al. 1996, PREMTI et al. 1996, MEKSHIQI et al. 1996) is not done on the structural data as proposed by CASSARD et al. (1981). Last years, the deformation structures (foliation and lineation) were mapped out for the peridotites of Kukesi massif (HOXHA & BOULLIER 1995), Bulqiza massif (MESHI 1996), Tropoja and Krrabi massifs (MESHI, BOUDIER, NICOLAS; unpublished), Lura massif (PECA & MESHI, unpublished). In addition, internal structures of numerous chromite bodies are evaluated. In the structural maps are shown the size of chromite deposits (Fig. 3a, 5a, 6a), while the classification of the ore bodies as concordant, subconcordant and discordant is based on the relationships of their structures with respect to the deformation structures of the surrounding peridotites. Chromite occurrences in the Western ultramafic massifs are rare, small in size, generally uneconomic, and belong mainly to the concordant structural types. In this paper only structural types of chromites of e the Eastern massifs (Fig. 3a, 5a, and 6a) are described.

Concordant ore bodies. Their morphology varies from the lens, pencil and flattened pencil-like to pencil-lens like. The typical examples of the lens-like ore bodies are found in Kukesi massif (ore body No. 1) (Fig. 5b, c, d), in Bulqiza massif (upper part of Theken deposit), in Tropoja massif (Vlahen ore deposit), (Fig. 6b, c, d). The flattened plane of the lens-like ore bodies is parallel to the foliation, whereas their elongation is parallel to the lineation in surrounding peridotite. The last one shows a strong planar and linear structure. Typical representatives of pencil-like ore bodies are those of Shkalla ore deposit (Fig. 4a, b, c), Lucana ore deposit both from Bulqiza massif, ore body No. 1 of Are Lere ore deposit from Kukesi massif etc. The long axis of these ore deposits is parallel to the strong linear structures in the surrounding peridotite. Flattened pencil-like ore bodies are characteristic for Tropoja massif, ore body No. 2 at Rrogam deposit, ore body No. 2 at Maja e Lajthizes ore deposit etc. Elongation and flattening of these ore bodies correspond to the strong linear and planar structures in surrounding peridotite. Thekna ore deposit of Bulqiza massif exhibits an interesting example of the contrast between lower part of ore body (pencil-like) and its upper part (lens-like). Concordant ore bodies exhibit various textures but all of them show intensive ductile deformations. In Lura massif, ore bodies are pod-like, small in size and generally uneconomic. Pods are flattened according to the foliation plane and elongated in conformity with the lineation in surrounding peridotite.

Subconcordant ore bodies. Such ore bodies exhibit isoclinal folds, where their long flanks are concordant, whereas the short ones are discordant to the foliation in surrounding peridotite. The best example of this type is Bulqiza ore deposit (Fig. 3e), unique in size for all alpine-type ophiolites. To this group belongs Zogaj ore deposit in Tropoja massif (Fig. 6a). These chromitite are located at the periphery of mantle diapirs of Bulqiza (Fig. 3a) and Kepenek (Fig. 6a). Subconcordant type chromites of New Caledonia (CASSARD et al. 1981) are different from those of Albania, because in the last ones the high temperature planar structure is steep up to moderate. This type supply the major chromium production for Albania.

Discordant ore bodies. Numerous ore bodies in Albania belong to this group (Fig. 3a, 5a, 6a). They are small in size and generally uneconomic. Ore bodies are of vein, lens-like and of schliere morphology. They are found mainly within the transition zone dunites above the diapir or at its periphery. Off axis discordant chromite ore bodies are also frequently observed. In dunites of the transition zone of Bulqiza massif, a chromite vein lens-shaped body is located into the center of the intrusive pegmatite clinopyroxenite vein. It is discordant to the foliation in the surrounding dunite. The main chromite occurrence in the clinopyroxenite is associated with small lenses of chromites up to 1-2 cm. This chromite type exhibits massive, disseminated, schliere, banded and nodular texture, which are undeformed or lightly deformed. It is interesting to note that Ajazaj chromite body is of high - Al type although it is located in the same „stratigraphical" level as Bulqiza ore deposit, which is rich in chromium. Ajazaj chromite outcrop in Bulqiza massif (Fig. 3a) indicate 50 E 50. It is discordant to the foliation in surrounding peridotites showing 160 W 70°. Although the chromite ore is typical discordant, the disseminated ores display a pull-a part structure (NICOLAS, personal communication).

6. Discussion

The irregular distribution of chromite deposits in the Northern Mirdita ophiolite (Albania) is very ambiguous and controversial. Some questions may be arisen. Why in the Eastern massifs are found the abundant chromite deposits, while in the Western ones (30 km far) the chromites are scarce? Why in the Eastern massifs, more than 90 % of reserves are concentrated into the Bulqiza massif? Why the main accumulations are located into the harzburgites near the contact with transition zone dunites? Why the discordant ore bodies, even in the majority, are of no economic significance and in the sharp contrast with the concordant and subconcordant types? Why the chromitites concentrated in thick dunite bodies within the harzburgites are of low grade, while those with thin dunite envelope or in the direct contact with harzburgites are of the high grade? Why the Bulqiza subconcordant deposit (the richest one in chromium [100Cr / (Cr+Al), 79]) and the Ajazaj discordant occurrence (the richest one in aluminum [100Cr / Cr+Al), 65]) are found in the same site?

The chromite of Mirdita ophiolite show a high diversity of Cr-number [100Cr / (Cr+Al), 43-84] and Mg-number [100Mg / ($Mg+Fe^{+2}$), 27-78], (Cina 1986). Such diversity is reported also for Kempirsai chromite deposits, Kazakhistan (Melcher et al. 1997) and for Uktus Uralian-Alaskan-Type complex (Garuti et al. 2003).

The recent studies argue that the Mirdita ophiolite is not dismembered from the orogenic deformations (Nicolas et al., 1999). When conducted in ophiolites which have not been dismembered by orogenic deformation, structural and kinematics studies cast a new light on their origin and history (Nicolas 1989). In this context, the discussion related to the structural and kinematics evidences of Mirdita ophiolite with respect to chromite structural setting make up an important tentative approach to the explanation of the origin and the evolution of the chromites.

6.1. Role of the temperature and the oxygen fugacity in chromite concentration

The irregular distribution of the chromite deposits within the ophiolites has been attributed to their nature (Nicolas 1986). Empirically it is evident that major ore deposits are restricted to the harzburgite dominant sequences (Den Tex 1969, Jackson & Thayer 1972, Boudier & Nicolas 1885, Roberts 1988). In general they are absent to the lherzolite type ophiolites. According to this scheme, the eastern chromite bearing massifs are distinguished from the western one (Cina et al. 1987). The detailed structural mapping (Nicolas et al. 1999) reveals that in both ophiolite belts the deep mantle peridotites are clinopyroxene-bearing harzburgites. The major difference between the two belts is evidenced into the upper part peridotites close to the contact with the crust units and within the same crust section. In the western massifs, the plagioclase peridotites are developed, meanwhile in the Eastern areas the transition zone dunites are distributed. In the East, the crust is of the normal ophiolitic type, while in the West, the crust units are incomplete. The central and eastern parts of the Mirdita corridor would correspond to an episode of 'magmatic" spreading and the western part, to an „amagmatic" spreading (Nicolas et al. 1999). In this optics, to the eastern ultramafic massifs correspond an important magmatic budget, which is responsible for the mobilization and the chromium liquid saturation, but it seems not sufficient enough.

The nature of the Oman mantle and crust (Nicolas 1989) testify for a more important magmatic budget with respect to Eastern Mirdita ophiolite. Although it is to underline that the Oman ophiolite is poorer in chromite deposits as compared with other Eastern Mediterranean ophiolites (Albania, Turkey etc.). The crust thickness of Eastern Mirdita is thin (max. 3 km) compared with those of Oman (6 km). The Oman mantle section is harzburgite depleted, while in Mirdita it is of clinopyroxene harzburgite composition. The most important chromite deposits in Oman are found into the transition zone dunites. In this aspect, Kuksi massif in Albania (Fig. 5a), demonstrate some similarities with Oman massif. Nicolas & Al Azri (1991) have explained this by the mantle cooling and the possible increase in oxygen fugacity affecting this zone below an oceanic ridge like two factors which would favor chromite and olivine crystallization from the rising melt.

Murck & Campbell (1986) have described experiments suggesting that the solubility of the Cr^{3+} ion within the melt is strongly dependent on temperature and that any significant descent of the temperature would result in the saturation of the melt with the respect to chromite. Thermic structures are in dependence from the velocity rate of the oceanic ridge spreading (Nicolas & Al Azri 1991). Bulqiza ultramafic massif exposes the features of the oceanic lithosphere produced in the conditions of the low to moderate velocity spreading. The thermic structures created in such conditions favorite important chromite concentrations within harzburgites close to the contact with transition zone dunites. This is one of the main reasons why the most important chromite deposits of Albania are found within harzburgites of Bulqiza massif (500 m below the transition zone/harzburgites limit). Very interesting is the contrast between the high-grade (over 35 % Cr_2O_3) chromite bodies with dunite thin envelope found in harzburgites (or of the ore bodies with sharp contact in harzburgites) and the low-grade (20-25 % Cr_2O_3) chromite bodies located in the transition zone dunites or within thick dunite lenses in harzburgites. In harzburgites of Bulqiza massif, the concordant bodies are 50 m far from each other. One ore body of layered texture (18 % Cr_2O_3), 2 m thick is located within a dunite lens 25 m thick, while the neighbor body is of massive texture (over 47 % Cr_2O_3), 1 m thick and in direct contact with harzburgites. The same contrast demonstrates the ore bodies No.1 and 2 of Kalimash 2 deposit in Kuksi massif (Fig. 5a) (see the above paragraph). Regarding the dunite origin, it is suggested that these rocks are the result of melt/solid inter-reaction (Kelemen et al. 1990) or of pyroxene preferred incongruent melting (Boudier & Nicolas 1972). Nevertheless the different ideas, the dunite bodies are considered as product of harzburgite transformation by the hot highly reactive magma. The various size of dunite bodies have registered the thermic gradient degree developed during the adiabatic processes of the rising mantle. The thick and the dense dunite lenses correspond to the high thermic flux. It is responsible for the generation of the uprising liquids tending to accumulate into the magmatic cameras. This process is associated with the chromium transport into the upward magmatic chambers.

The absence of chromite deposits in the Western massifs can not explained only by the magmatic budget deficit. Same situation is also observed in Othris massif, Greece (BARTH et al. 2003, DIJKSTRA at al. 2001) which is the southern continuation of western massifs of Albania. Within the plagioclase peridotites, abundant flaser gabbroic bodies of various sizes, locally from several tens to several hundred meters are observed. This fact indicates an intensive percolation of the magmatic liquids. In the Western massifs, the uppermost mantle is composed of highly strained to mylonitic lherzolites which originate from more depleted harzburgites by impregnation and tectonic dispersion of melt during deformation occurring at 1000-800° C (NICOLAS et al. 1999). The lack of the important chromite concentrations is the result of the low temperature or of the presence of plagioclase saturated magmatic liquid? The peridotites of transition zone in Kopdag ophiolite (NE Turkey) are composed of clinopyroxene dunite, wehrlites, lherzolites, clinopyroxenites (MESHI et al. 1997). In that environment are located important chromite deposits of concordant and subconcordant type (several million tons), while in the sub adjacent harzburgites rare and not important chromite occurrences are found. Abundant subconcordant and concordant clinopyroxenite bodies, up to 10 m. thick are developed. The low-T and high strain deformations observed in the Kopdag transition zone are similar to those ones evidenced in the Western Mirdita massifs. It remains open the question if the contrast between the Kopdag massif saturated in chromium and the Mirdita Western massifs with scarce chromite concentrations is the result of the melt saturation with Cpx and Pl or the Kopdag chromite deposits are formed before the impregnation and the tectonic dispersion of the melt. The second suggestion is rather difficult to be accepted because no melt impregnation traces into the chromite bodies are observed.

Another important factor for the abundant chromite crystallization is the increase of the oxygen fugacity (ULMER 1969, HILL & ROEDER 1974, IRVIN 1977, IRVIN 1978). It is conditioned by the water fluids in the magmatic system (LORAND & CEULENEER 1989, MC ELDUFF & STUMPFL 1991, MELCHER et al. 1999). Unfortunately no studies are carried out on the hydroxyl minerals and the fluid inclusions in the Albanian chromitites. This one surely would cast a new light on the question if the mantle fluids are delivered from magma or fluids are related to the early and deep hydrothermal percolation installed under the oceanic ridge. The structural evidence from the upper part mantle harzburgites, the transition zone dunites and the layered gabbros of the lower crust levels indicate significant traces of the hydrothermal percolation. It is compatible with a thin crust corresponding to Eastern ophiolite massifs and with an incomplete crust of the Western massifs. In the studing of fluid inclusions, it is important to evaluate these ones with respect to the structural chromite type. The concordant ores are very poor in mineral inclusions in contrast with the discordant ores rich in inclusions (LORAND & CEULENEER 1989).

6.2. Mantle diapirs as favorable sites for chromite occurrence

The diapiric structures correspond to the rich bearing chromite zones, as for example in Maksad (Oman) (CEULENEER & NICOLAS 1985), in Acoje of Zambale massif (Philipines) (NICOLAS & VIOLETTE 1982), in Guleman (Turkey) (USUMEZSOY 1990), in Pozanti (Turkey) (MESHI et al. 1997). Melt extracted from the mantle is dominantly channeled through such diapirs towards magmatic chamber (RABINOWICZ et al. 1984, NICOLAS 1986). It is assumed that most of the chromite is formed by early crystallization from this melt at top of the diapir (NICOLAS & AL AZRI 1991). In the Eastern Mirdita belt (Bulqiza massif) is registered a mantle sub vertical flux structure (MESHI 1996) (Fig. 3a). It remains open the question if the zone contoured by the isodip 45° (Tropoja massif) (Fig. 6a), correspond to a diapiric structure or this picture is related to the shear bands inside the high-T domain. The Tropoja massif shows a network of minor low-T shear zones, which have not been systematically mapped (NICOLAS et al. 1999). From this point of view, this massif show intermediary features between the Eastern and Western massifs. The majority of the chromite deposits are located in/at periphery of the Bulqiza diapiric structure (Fig. 3a) and to the contoured zone by the isodip 45° in Tropoja massif, (fig. 6a).

6.3. Chromitite form and ductile deformation in surrounding peridotite

The relationships between the chromite ore bodies morphology and the ductile deformation in chromites and the surrounding rocks had been discussed by CASSARD et al. (1981). The model of CHRISTIANSEN (1986) suggest that the form of a chromite deposit can be influenced by early high temperature (ridge-axis) fabrics through to latter sin and past emplacement thrusting and faulting. The role of emplacement fabrics influencing the form of the chromite deposits was further described by ROBERTS et al. (1988) for the Vourinos complex. The initial formation and location of the deposits is more likely the direct result of magmatic processes. However, understanding the structural relationships in detail is a necessary perquisite to the deformation of ore receives and the prediction of any „down dip“ extension of known mineralization (ROBERTS & NEARY 1993).

In chromite deposits of Northern Mirdita ophiolite is clearly evidenced the influence of high temperature deformation in their morphology. A strong planar anisotropy of astenospheric mantle flow evidenced in mantle section of Kuksi massif is responsible for lens-like form of chromite deposits. A strong linear anisotropy of astenospheric mantle flow had been evidenced in mantle harzburgite where pencil-like deposits are located. Strong linear anisotropy is typical for rising mantle flow in diapiric structures. At the top of diapiric structures frequently are observed plastically deformed bodies, (the deeper part of Theken ore deposit, which is located at the top of Bulqiza diapir). Intensively linear deformed pencil-like bodies are present at the top of diapiric structure of Pozanti massif, Turkey (MESHI et al.1997). Pencil-like bodies showing strong linear deformation located at the top of diapir suggest their formation into the depth. Later they are tectonically transposed during mantle vertical rising. Pencil-like ore deposits of Shkalla and Lucana in Bulqiza massif showing characteristics of intensive linear deformation, which are located in off-axis sites, are in concordance to strong linear structures observed locally in the surrounding harzburgite (MESHI 1996). Local strong linear structures can be explained by the existence of mantle flow channels, with comparatively are more stagnant zone in between (ILDEFONSE et al. 1995).

Ore deposits showing the isoclinal folds are controlled by planar and linear structures of asthenospheric flow. Axial plane and axis of these folds correspond respectively to planar and linear structures of high-temperature mantle flow. Folding geometry of Bulqiza deposit (Fig. 3e) show the same shear sense as that one determined for surrounding mantle harzbugite deformed in high temperatures (MESHI 1996).

Discordant ore bodies form are controlled by structures of dike-like type or shear zones of centimeter up metric trend as in the case of Ajazaj occurrence in Bulqiza massif.

7. Conclusions

The most important chromite deposits in the Northern Mirdita ophiolite are discovered in the Eastern ultramafic massifs. Bulqiza and Kepeneku (Tropoje) diapirs are distinguished by the presence of abundant chromites showing economic interest. The majority of economic ore deposits are located within depleted harzburgites, 500 m beneath harzburgite transition zone limit. The less important ore deposits (low quantity reserves and of low ore grade) are discovered and mined out also in the transition zone.

Based on the relations of chromite structures with deformation structures of the host rocks, concordant, subconcordant and discordant bodies are distinguished. Subconcordant ore deposits are the most important ones concerning quantity and quality, whereas those of concordant type are of the second hand interest. In contrast, discordant chromites although being numerous do not show economic interest because of their small size. High temperature deformation fabric in surrounding peridotite influences to the form of concordant and subconcordant type ore deposits. These conclusions constitute a guide on prospecting and mining of chromites in the Mirdita ophiolites.

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