Iraqi Geological Journal

Journal homepage: https://www.igj-iraq.org

The Obstacles and Opportunities of the Mineral Resources in the Kurdistan Region, Iraq

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Received: 19 July 2021; Accepted: 21 August 2021; Published: 31 October 2021

Abstract

The Kurdistan Region in Iraq is located in the extreme northeastern part of the Arabian Plate which is in a collision since the Late Cretaceous with the Iranian Plate. Therefore, large ophiolite bodies have been thrust along the northeastern margins of Kurdistan Region; accordingly, different metallic mineral can be associated with igneous and metamorphic rocks at Penjween, Qalat Diza and Rawandouz vicinities, besides, radioactive minerals like uranium and thorium. Moreover, large and long thrust fault has developed along the northern and northeastern parts of the Kurdistan Region. Along the plane of this huge thrust fault, hydrothermal liquids have deposited different metallic minerals as showings, especially between Zakho and Amadiyah towns. We have presented and discussed the discipline of mineral investment in Kurdistan Region, the announced minerals' blocks for investment by the Ministry of Natural Resources in the Kurdistan Regional Government, the encouraging factors and obstacles of investments. To fulfill the scope of this work, we have used the best available and updated data as acquired from different sources. The main obstacles which contributed to the backwardness and non-development of the mining industry in the Kurdistan Region can be summarized in the nonexistence of a valid and promising mineral investment law which can attract the big international mining companies to invest in the region, adding to the nonexistence of comprehensive, detailed and mineral exploration studies which can give confident figures of the mineral and ore reserves in the region. The non-availability of a specialized mining education institution which prepares mining expertise and mining engineers who can lead the progress in this regard could count as another hurdle.

Keywords: Kurdistan Region; Law of mineral investment; Minerals blocks for investment; Mineral wealth; Ministry of Natural Resource.

1. Introduction

The mineral wealth in Kurdistan Region (KR), especially the metallic minerals has developed mainly due to the collision of the Arabian and Eurasian (Iranian) plates (Al-Bassam, 2013; Sissakian, 2018; Sissakian et al., 2021). The collision which has started since the Late Cretaceous and is still

DOI: 10.46717/igj.54.2D.8Ms-2021-10-27

ongoing (Berberian, 1995; Alavi, 2014; Fouad, 2015) has formed thrust faults by means of which huge ophiolite bodies were emplaced in KR (Al-Mehaidi, 1974; Ali et al., 2012; Awadh, 2019), especially in the northeastern parts at Penjween, Qalat Diza and Rawandouz vicinities (Fig. 1). The ophiolite bodies consist of igneous and metamorphic rocks (Mirza, 2008; Ismail et al., 2009, Karim et al., 2015) which witnessed interesting minerals' showings; such as chromite, copper, iron. On the other hand, at the northern parts of KR, where no ophiolite bodies were reached by thrusting, hydrothermal liquids have deposited different minerals along the fault planes (Hassan et al., 1991;, Jassim and Goff, 2006; Yassin, 2009; Yassin and Mahmoud, 2012 and 2019).

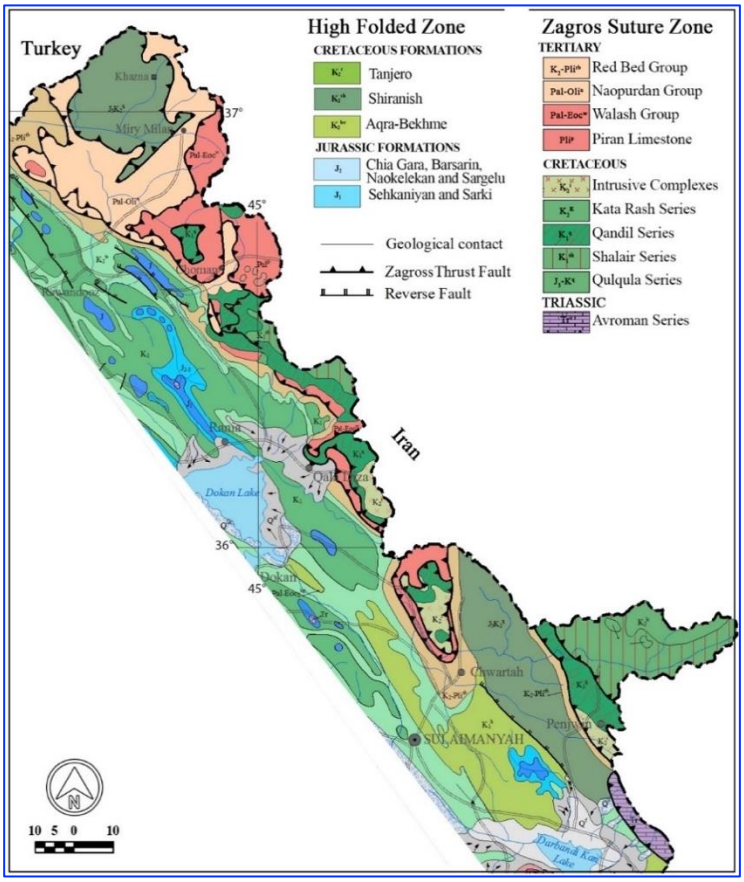

Fig. 1. Geological map showing the thrusted ophiolite bodies inside the KR (After Sissakian and Fouad, 2012)

Awadh (2006) studied the Zn-Pb occurrences and genesis at NE of Zakho, Awadh et al. (2008) studied the Zn- Pb – Barite occurrences in carbonates at Zakho vicinity, Merza (2008) studied the Mawat Ophiolite Complex and mentioned about the Cu, Cr occurrences, Yassin (2009) studied the Fe- deposit at Banavi, which is located NW of Amadiyah town, Awadh and Nejbert (2016) studied the polymetallic sulfides at Alanish, which is located NE of Zakho town, Awadh (2019) studied the Zn- Pb occurrences in the Northern Thrust Zone, Mirza and Rashid (2019) studied the occurrences of Cr and Platinum groups in the KR, Yara (2019) studied in details Cu occurrences in KR. This study covers the main locations in KR where minerals' showings were recorded; some of them were studied at different levels; accordingly, low, medium and medium-high Levels of confidence can be considered; according to JORC (1999) classification. The interesting minerals' occurrences and showings are located along the

northern and northeastern parts of KR, where the Ministry of Natural Resource (MNR) has shown those occurrences and showings in seven blocks (Fig. 2) which were prepared for the purpose of international investments. The aim of this work is to present and discuss the opportunities of minerals' investments in KR, the main encouraging aspects, as well as the main obstacles for mineral exploration and investments.

2. Materials and Methods

Different data have been used to update the current work, among them are published scientific articles, reports in MNR and the Iraq Geological Survey libraries, and field observations of the authors.

Among the reviewed and/ or used literatures are, but not limited to: Buday and Vanacik (1971); Jassim and Goff (2006); Al-Bassam (2007 and 2013); Mirza (2008); Mohammad (2008); Yassin (2009); Ismail et al. (2009); Mahmoud et al. (2010 and 2011); Ewaz et al. (2011); Yassin and Mahmoud (2012 and 2019); Karim et al. (2015); Sissakian (2018); Yara (2019). We have mentioned and discussed the main aspects which will furnish and shed light on the opportunities to explore, investigate, invest and utilize the mineral wealth in KR. The current work is the continuation of a similar work conducted by Sissakian et al. (2021), in which the authors have reviewed and discussed the mineral wealth in KR.

3. Mineral Exploration History

The first carried out works of mineral investigation in KR dates back to the third decade in the last century. Later on, mineral investigation attempts were carried out at different time intervals; but none of them was performed relevantly in order to evaluate the mineral wealth in the region successfully. This is attributed to many reasons; some are scientific and others are related to other different reasons such as previous unrest and security. The main performed mineral investigations are briefed hereinafter, systematically.

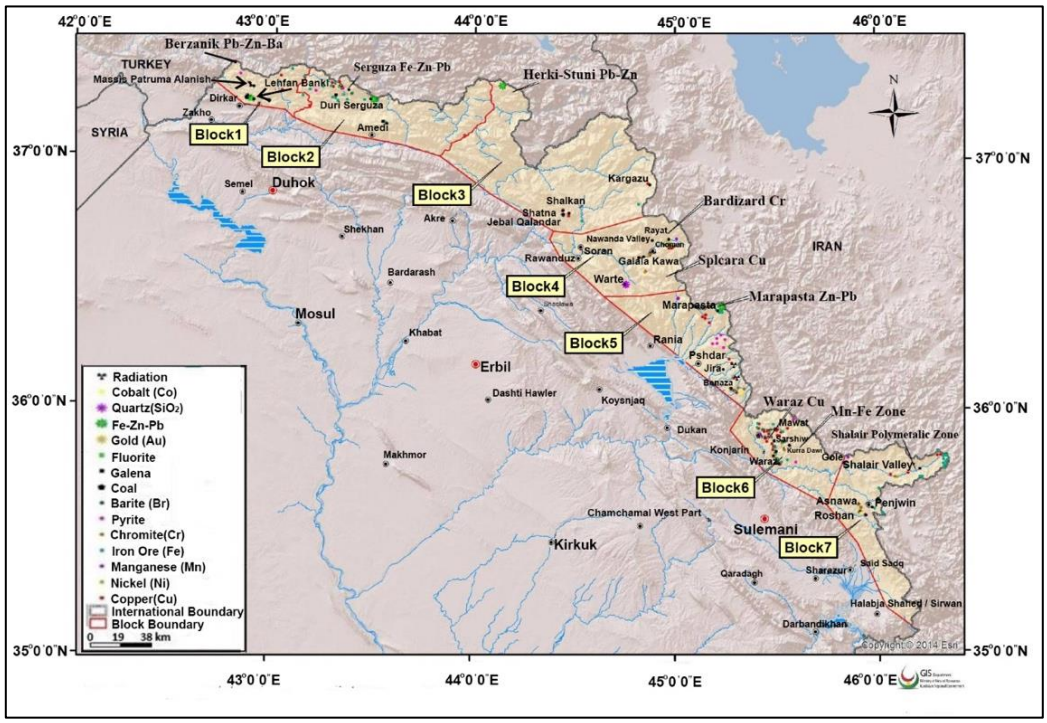

Fig. 2. Location of the seven mineral investment blocks (After MNR, 2016).

3.1. Site Investigation Co. (UK)

The first systematic mineral and geological investigation was carried out by Site Investigation Co. (England) during 1954-1958. The whole KR territory was divided into six blocks (K1-K6), (Fig. 3) covering the most potential areas for mineral occurrences based on hundreds of mineral showings.

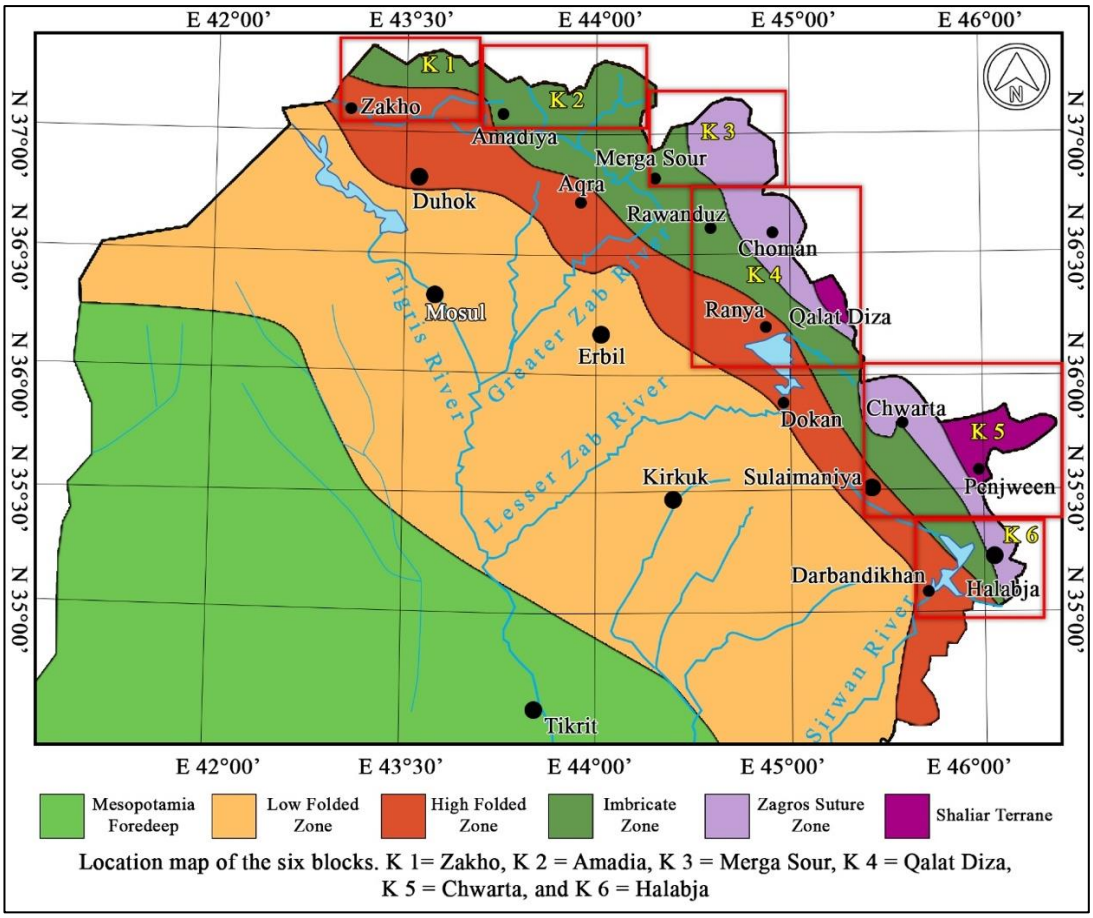

Fig. 3. Location map of the six blocks. K 1= Zakho, K 2 = Amadia, K 3 = Merga Sour, K 4 = Qalat Diza, K 5 = Chwarta, and K 6 = Halabja (After McCarthy and Hall (1954), Hall (1954), Stevenson and Cobbett (1954), and Bolton (1954 a, b and c), respectively)

3.2. Iraq Geological Survey (GEOSURV)

Iraq Geological Survey started an ambitious project to cover the whole Iraqi territory by mineral investigation and geological mapping since 1971 and continued till 2009. Accordingly, the main mineral investigation works in KR were performed by GEOSURV. However, the carried-out works were terminated at different time intervals during the mentioned period for different reasons; like political unrest, the Gulf War 1 and 2. In the KR, geological maps of 1:250000 scale are available, and are published in 36 quadrangles, and unpublished geological maps at a scale of 1:100000 which are deposited in the archive of GEOSURV. Moreover, geological maps of 1:20000 scale are available, which are prepared for mineral investigation purposes, like in north and northeast of Zakho until the Greater Zab River (Masin et al., 1971; Hamza and Iasac, 1971; Geozavod, 1981; Al-Bassam et al., 1982; Ma'ala et al., 1990; Al-Ka'aby and Al-Azzawi, 1991 and 1992; Misconi and Bunni, 1992; Yasin, 2009; Yasin and Mahmoud, 2012) and Mawat vicinity covering about 250 km^2 (Al-Mehaidi, 1974; Al-Hashimi and Al-Mehaidi, 1975).

3.3. Ex- Soviet Expedition

A Soviet expedition performed very restricted investigations during 1960-1962 at few localities within KR. The first one was near Penjween town where the Fe deposit at Asnawa was investigated. The main minerals in the ore are Magnetite (Fe_3O_4) with some pyrite, pyrrhotite, chalcopyrite and arsenopyrite. Teretenko and Khadikov (1961) estimated the reserve of the iron ore to be about 100000 tons. Mironov and Sitchenkov (1962) investigated the iron ore at Banavi village northwest of Amdiya town. They reported about the mineralization and mentioned that galena pebbles of size up to 2 cm can be seen in the scree. Besides, Vasiliev and Pentelkove (1962) studied the chromite ate Bardi Zard. Technoexport (ex-USSR) carried out exploratory works about Zn – Pb in the 1960. The acquired results from all these explorations are deposited as preliminary reports in GEOSURV's achieve.

3.4. Miscellaneous Works

Some very local and limited works of mineral exploration were carried out at different parts of KR by different firms; However, none of them reached even low level of confidence; according to JORC (1999) classification.

4. Minerals' Blocks for Investments

The MNR in 2016 has announced seven minerals' blocks (Fig. 2) for investment. The seven blocks are distributed along the northern and northeastern borders of KR. The coverage areas, governorate's names and district's names of the seven blocks are mentioned in Table 1.

Table 1. Characteristics of the seven mineral investment blocks (After MNR, 2016).

Block No.	Coverage area (km^2)	Governorate	Main towns	Main minerals showings
1	598.71	Duhok	Zakho	Zn – Pb
2	1775.24	Duhok	Amadiyah	Zn – Pb, Fe
3	3359.04	Erbil	Barzan, Mergasur	Zn – Pb, Cr, Cu
4	1591.62	Erbil	Rawandouz, Soran	Cu – Ni, Cr, Au
5	1379.37	Sulaimaniyah	Qalat Diza	Zn – Pb, Cu, Fe, U, Th
6	1135.04	Sulaimaniyah	Mawat	Cu, Fe, Cr –Ni, Co, Au
7	1512.23	Sulaimaniyah	Penjween, Halabja	Fe, Cu, Mn, U, Th, Au

According to the MNR announcement, 13 International mining and/ or mineral investment companies have submitted their offers to MNR in 2016. The companies are from different countries: Canada, USA, UK, China, Turkey, Iran, UAE, Iraq, France.

The locations and main mineral showings in the seven blocks are briefly mentioned hereinafter. The location maps of the seven blocks are presented in Figs. 4 -10 with common notes on each block.

- **Block 1:** This block is one of the interesting blocks, where tens of Zn -Pb occurrences and/ or showings were reported (Fig. 4). GEOSURV carried out a lot of investigations, detailed geological mapping, geochemical and stream samples exploration and drilling. However, none of the studied sites reached Medium Level of Confidence according to JORC (1999) classification.
- **Block 2:** This block is very interesting and encouraging block, since tens of Zn-Pb and Fe occurrences and/ or showings were reported (Fig. 5). GEOSURV carried out a lot of investigations, detailed geological mapping, geochemical and stream samples exploration and a lot of drilling. However, none of the studied sites reached Medium Level of Confidence according to JORC (1999)

classification. Nevertheless, Surguza site can be considered as Medium Level of Confidence due to a lot of drilling carried out by GEOSURV and Geozavod (1981).

- **Block 3:** This block is the less interesting one, this is attributed to its very rough terrain, absence of main towns, and very little mineral showings (Fig. 6). None of the mentioned companies have submitted investment offer in this block.
- **Block 4:** This block is one of the interesting and encouraging blocks. It includes Cr, Fe, Cu and Au occurrences (Fig. 7). Ex-Iraqi Atomic Commission carried out a lot of investigations, detailed geological mapping, geochemical and radiometric explorations in this block.
- **Block 5:** This block is very interesting and encouraging, since tens of Zn – Pb, Fe and U and Th occurrences and/ or showings were reported (Fig. 8). Ex-Iraqi Atomic Commission carried out a lot of investigations, detailed geological mapping, geochemical and radiometric explorations in this block. GEOSURV also carried out mineral and geochemical exploration, geophysical traversing and drilled a lot of boreholes to estimate the Zn -Pb reserves. However, none of the studied sites reached High Level of Confidence according to JORC (1999) classification.
- **Block 6:** This block is the most interesting and encouraging block, since it is considered as Cu province called Mawat, besides the presence of Cr and Au occurrences (Fig. 9). GEOSURV carried out a lot of investigations, geological mapping, geochemical exploration, geophysical traversing in this block. About 850 samples were collected from an area of 250 km^2; all collected samples were subjected to chemical analyses. They found out that Cu concentrations range from (4000 – 67140) ppm, however, Ali (2106) found out 100000 ppm concentration of copper near Waraz village. GEOSURV drilled one exploratory well to a depth of 270 m, whereby Cu traces were found through the drilled depth. This block can be classified as Medium – High Level of Confidence based on JORC (1999) classification.
- **Block 7:** This block is one of the interesting and encouraging blocks. It is the only block which includes a mine in KR, it is iron mine near Asnawa village, east of Penjween, besides the presence of Cu, Cr and Au as occurrences (Fig. 10).

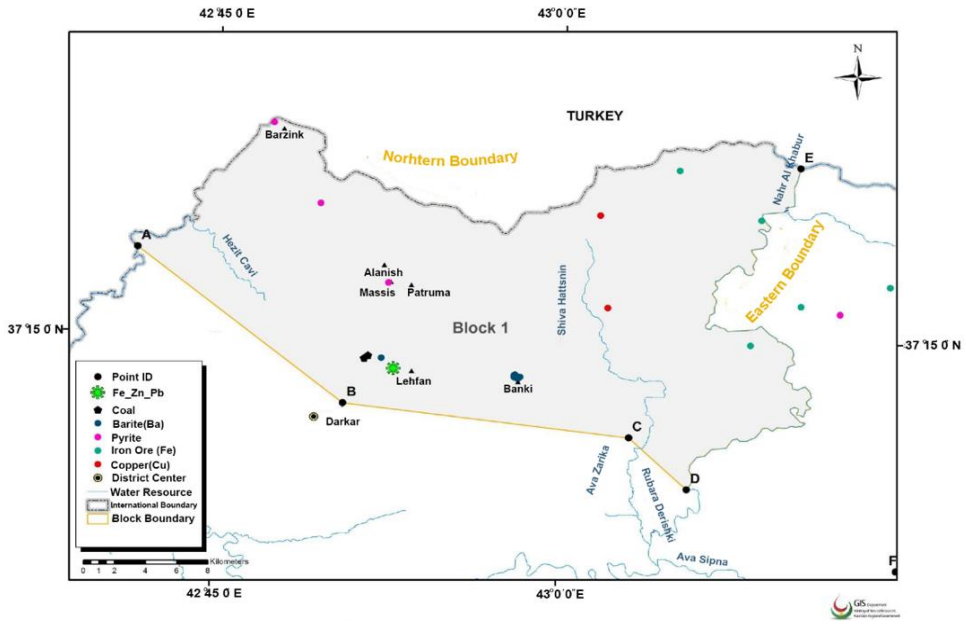

Fig. 4. Location of Block 1 for mineral investment (After MNR, 2016)

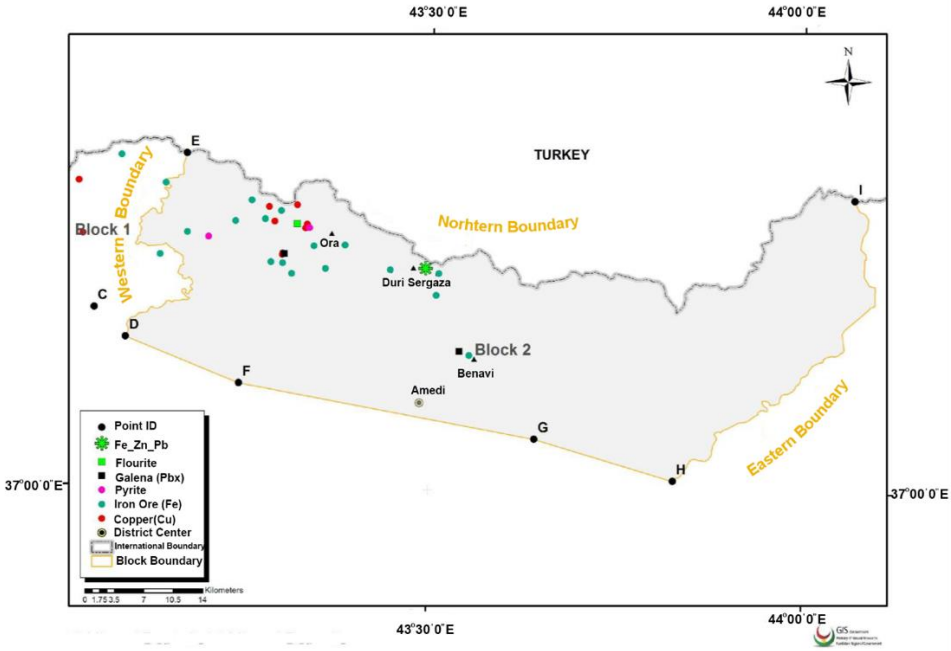

Fig. 5. Location of Block 2 for mineral investment (After MNR, 2016)

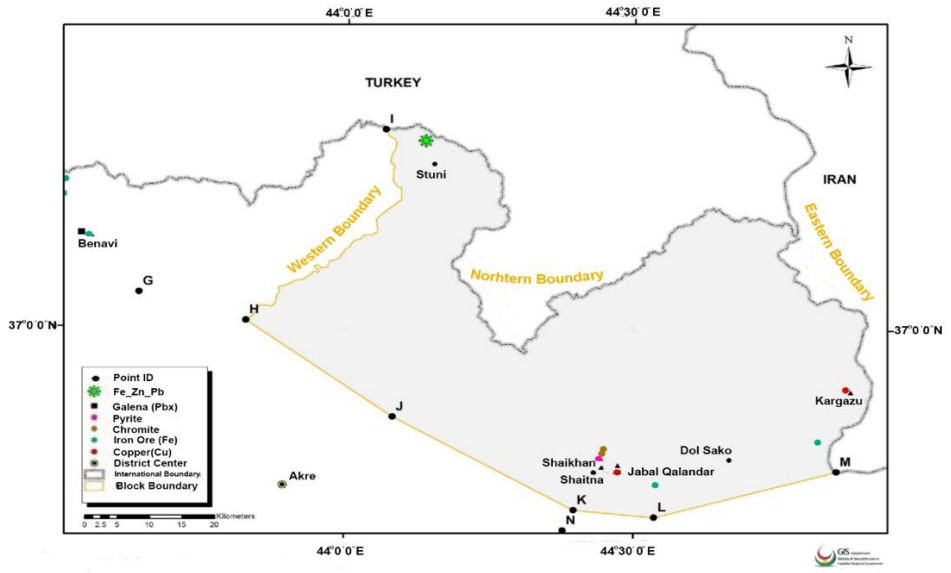

Fig. 6. Location of Block 3 for mineral investment (After MNR, 2016)

5. Future Opportunities

The mineral wealth in KR is very interesting with tens of showings, occurrences, partly explored deposits with Medium and Medium – High Levels of Confidence according to JORC (1999) classification (Al-Bassam, 2013, Sissakian, 2018). Therefore, a lot of future opportunities exist in KR as it was announced by MNR in 2016 to invest the seven minerals' blocks (Fig. 2). We have briefed the mineral exploration and investment opportunities hereinafter with general comments for future opportunities for each given site.

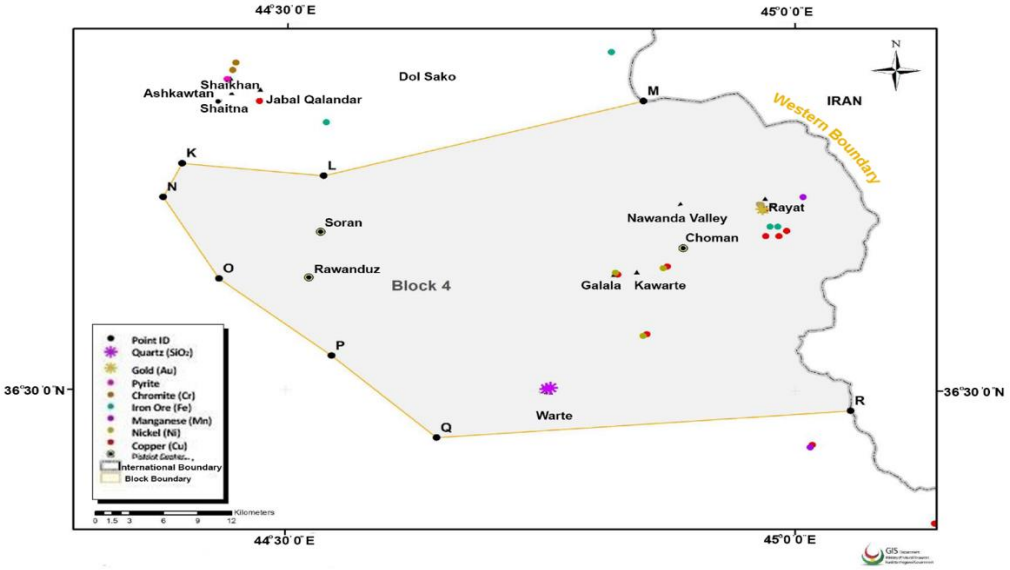

Fig.7. Location of Block 4 for mineral investment (After MNR, 2016)

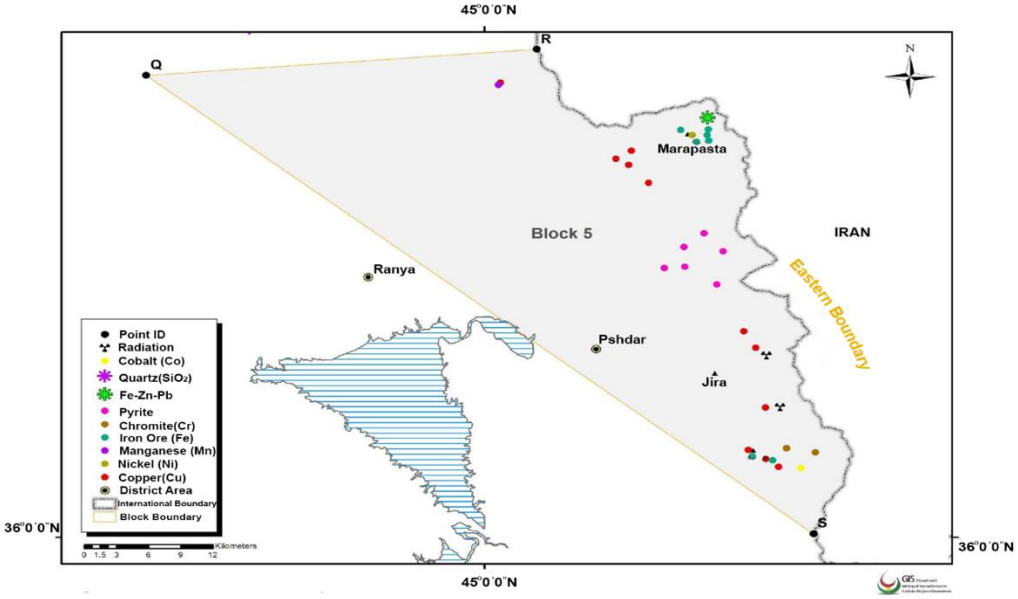

Fig. 8. Location of Block 5 for mineral investment (After MNR, 2016)

5.1. Copper Deposits

Copper deposits in Mawat vicinity (Fig. 9) is the most promising site for mineral exploration and then investment. This is attributed to the bulk of carried out work by GEOSURV during 1973-1974 and 1990-1991. Unfortunately, the data of the drilled exploratory well which was drilled down to 270 m was lost due to the events of 1991; accordingly, the evaluation and reserve estimation was not performed, otherwise the deposit can be classified as High Level of Confidence based on JORC (1999)

classification. It is worth to mention that the maximum recorded concentration of Cu was 100000 ppm (Ali, 2016).

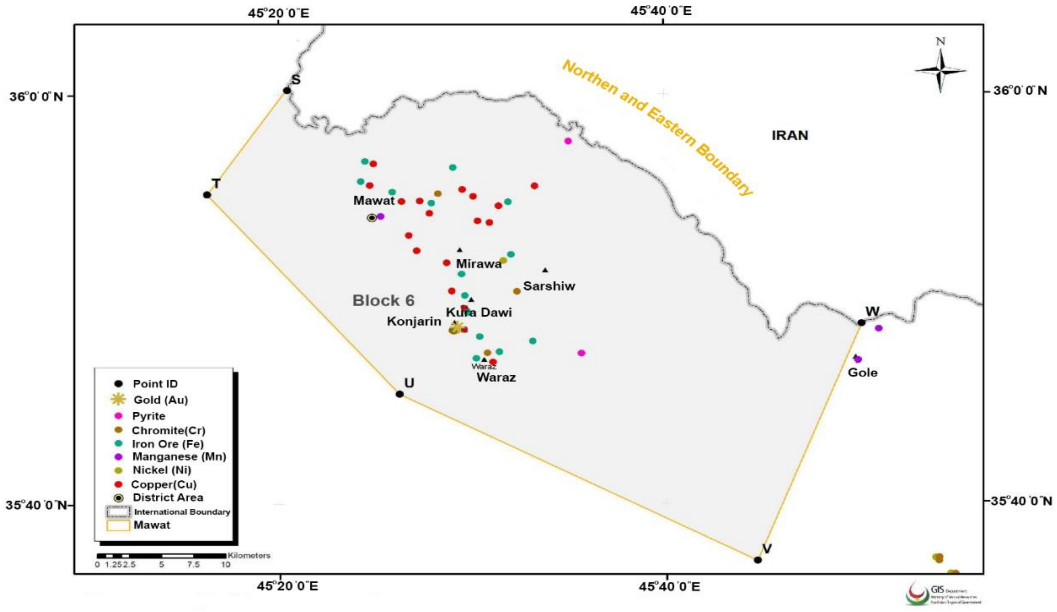

Fig. 9. Location of block 6 for mineral investment (After MNR, 2016)

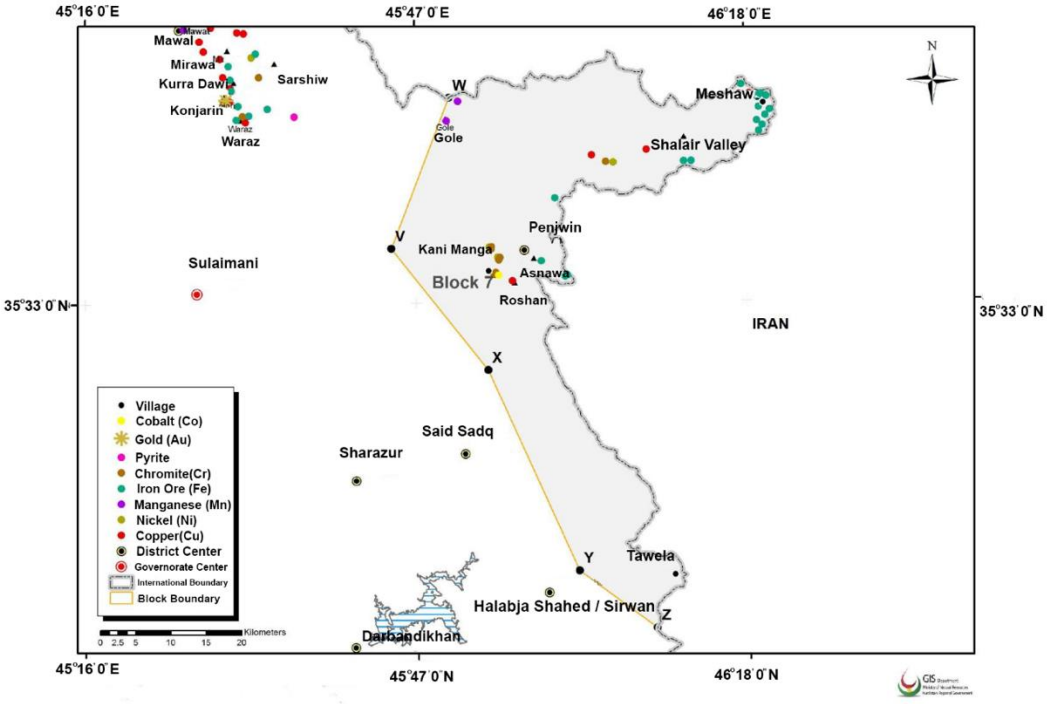

Fig. 10. Location of block 7 for mineral investment (After MNR, 2016)

5.2. Iron Deposits

Two sites in KR are promising areas for future opportunities to conduct mineral exploration and then investment. First is Asanawa Fe-deposit (Fig. 10), where iron is already mined from a very primitive quarry by a local miner (Fig. 11). Geophysical prospecting with boreholes drilling will give accurate estimation of the ore body, especially its subsurface extension, since the exposed part is like a vein in igneous rocks. The second encouraging site for Fe-deposit is in Banavi and Surguza (Fig. 5). The true estimation of the reserve cannot be done unless the subsurface extension of the deposit is studied by means of geophysical studies, then confirmed by borehole drilling.

Fig. 11. a) Asnawa iron ore mine, b) The crushing and sieving plant with ore stock pile (2018)

5.3. Zn– Pb Deposits

The Zn-Pb deposits in KR are also restricted to two sites. First is Marapasta, east of Qalat Diza town (Fig. 8), where GEOSURV drilled 20 boreholes and estimated the reserve of Zn and Pb to be 100520 tons and 18117 tons, respectively. However, this estimation is not accurate, because the drill boreholes were limited to a depth of 42 m only due to the limitation of the used portable small drilling machines (Akif and Mustafa, 1974). The second site is in Serguza; located NW of Amadiya town (Fig. 5). Geozavod (1981) drilled many boreholes to estimate the reserve of the Zn-Pb deposit and reported in two categories: For C1 category, the reserve is 1971000 tons including 42968 Zn, and 36069 Pb, whereas the C2 category reserve was estimated as 37000 tons of Zn, and 31000 tons of Pb (Al-Bassam, 2013).

5.4. Radioactive Minerals

These are represented by U and Th in KR and restricted to two main sites: First, Qalat Diza vicinity (Fig. 8), where at many localities different anomalies were recorded by ex-Iraqi Atomic Commission. The maximum recorded anomaly was in Shakhi Rash Mountain; where up to 3500 cps was recorded. It is worth to mention that a new radioactive mineral has been discovered in this area, named Iraqite (KCa_2(La, Ce, Th) Si8O20} (Al-Hermizy et al., 1976 in Mahdi, 2019). The second site is in Rawandouz vicinity, where radiometric surveys indicated anomalies, which showed (200-400) cps and up to 56 ppm U (Al-Kazzaz, et al., 1972).

6. Obstacles

Although the mineral wealth in KR is very interesting and has many encouraging aspects for International and local investors to start exploration and investment, however, there are many obstacles; some are scientific and others are not. The most significant obstacles have been briefly mentioned hereinafter.

6.1 Law of Mineral Investment

There is no Law of Mineral Investment in KR; hitherto. The absence of such a law is one of the main obstacles and discouraging elements for both International and local investors. The absence of an investment law which means that the investor can't keep his rights and his share from the investment.

6.2. Infrastructure

The majority of minerals' showings, occurrences and deposits in KR are located along its borders with Turkey and Iran (Fig. 12). All those areas are of very high relief and very rugged morphology; therefore, the existing infrastructure does not support the development of mining operations. The lack of the necessary infrastructure is another obstacle for investment. The most significant infrastructures which are absent in the involved areas are:

Lack of relevant roads, which can be used by heavy trucks,
The existing electrical power lines and efficiency,
Absence of rail ways, in all parts of KR, and
Absence of skilled workers with mining experience.
Nonexistence of relevant mining machinery in the region.

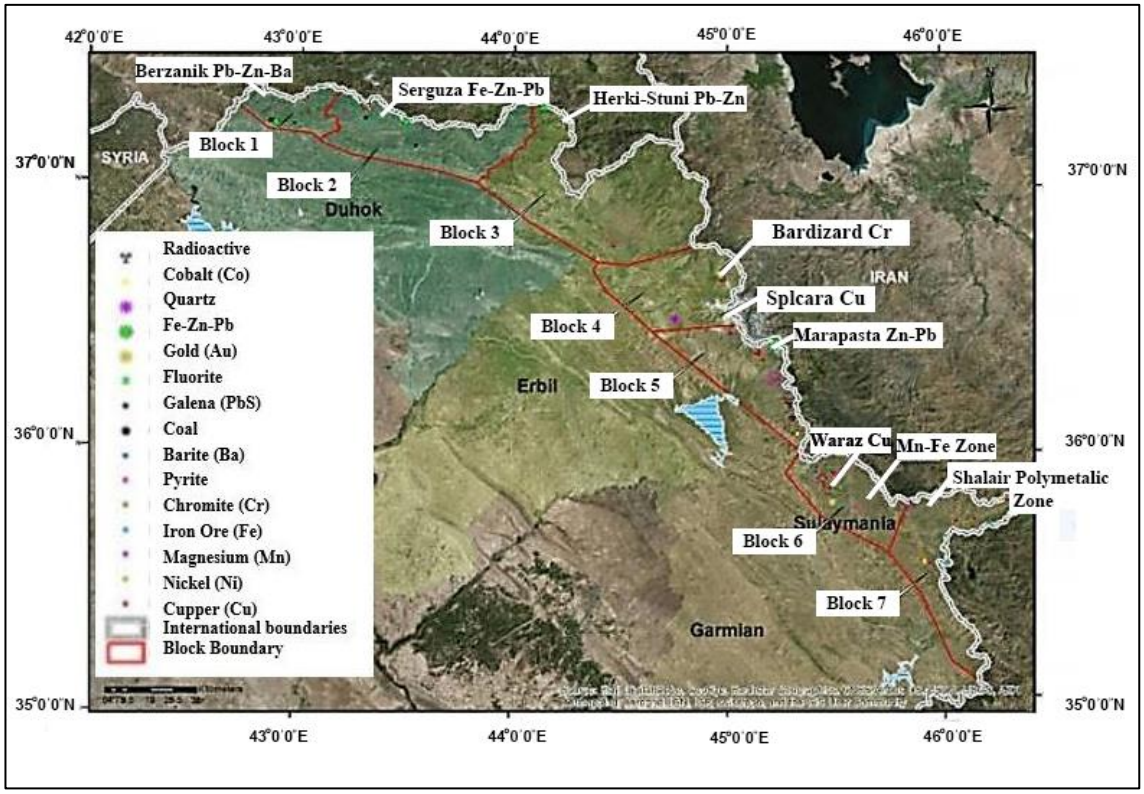

Fig. 12. Google Earth image of the seven blocks within KR. Note the rough morphology of the area.

6.3. Mining Culture

Mining culture in the local community in KR is almost absent. This is attributed to the lack of mining activities, apart from quarries of cement plants and other small quarries of different types of rocks for local uses. Therefore, the local investors, who have excellent capitals and are able to cover the required budget to start mining activities are not encouraged to take risk in using their capitals in such activities.

6.4. Security Aspects

The borders of KR where majority of the minerals' showings, occurrences and deposits are located suffer from security issues. The main aspects are: Millions of mines of different types occur along the borders since the sixties of the last century. The mines were buried during different times and majority of the used maps as indicators for the mine fields are already deleted and/ or lost.

The presence of some political parties represented by their military wings, have caused continuous bombing from Turkey and Iran to the border areas, causing a lot of causalities within the local villagers. The existing villages within the border areas were abandoned during the last decades of the last century. Therefore, those areas form almost empty zones from population, although very few villagers have returned back to their original villages, but still the areas are considered as remote and abandoned areas, like the coverage area of Block 3.

6.5. Heavy Industry

The whole of KR lacks heavy industry which uses metallic minerals. Therefore, when the existing mineral wealth is utilized, then their uses will represent a big obstacle due to lack of heavy industry in which the utilized minerals can be used. In other words, the local demand on the produced metals will be limited.

7. Discussion

It has been mentioned that there are a lot of minerals' showings and occurrences in the studied area. A promising prospect for a potential mining industry is thought to be anticipated in the future based on the expected mineral wealth in KR. Different metallic mineral showings can be seen associated with igneous and metamorphic rocks at Penjween, Qalat Diza and Rawandouz vicinities such as Fe, Cu, Mn, Zn-Pb, U, Th, Cu-Ni, Cr and Au. Besides, radioactive minerals like U and Th. Moreover, large and long thrust fault has developed along the northern and northeastern parts of KR. Along the plane of this huge thrust fault, hydrothermal liquids have deposited different metallic minerals as showings, especially between Zakho town such as Zn-Pb and Amadiya town such as Zn-Pb and Fe. Different governmental institutions and foreign companies have done some investigations which lead to the delineation of some areas in KR in terms of Blocks for the sake of attracting investors.

The MNR in 2016 has announced seven minerals' blocks (Fig. 2 and Table 1) for investment.A while earlier, the first systematic mineral and geological investigation was carried out by a British company during 1954-1958. They recognized six blocks (Fig. 3) covering the most potential areas for mineral occurrences based on hundreds of mineral showings.

Conclusions

This study has led to the following conclusions:

- Compared with Turkey and Iran, the mining industry in both KR and Iraq is in the primary stages and not well developed.
- The reasons for that are summarized in the following: The nonexistence of a promising mineral investment law in the region to encourage the foreign mining investors to invest in the region, in addition to the nonexistence of experienced mining companies (neither foreign nor local) in the region. The borders of KR where majority of the minerals' showings, occurrences and deposits are located suffer from security issues. One of the additional obstacles is that the mineral reserves in KR are not well studied, explored and estimated. The weak infrastructure in the region may add to those obstacles, adding to that is the fact that the whole of KR lacks heavy industry which uses metallic minerals which may give rise to marketing issues.
- The mineral potentials in KR are indicated as follows: Block 1 is one of the interesting blocks, where tens of Zn-Pb occurrences and/ or showings were reported. Block 2 is very interesting and encouraging block, since tens of Zn – Pb and Fe occurrences and/ or showings were reported. Block 3 is the less interesting one, this is attributed to its very rough terrain, absence of main towns and very little mineral showings. Block 4 is one of the interesting and encouraging blocks. It includes Cr, Fe, Cu and Au occurrences and/ or showings. Block 5 is very interesting and encouraging, since tens of Zn-Pb, Fe and U and Th occurrences and/ or showings were reported. Block 6 is the most interesting and encouraging block, since it is considered as Cu province called Mawat, besides the presence of Cr and Au occurrences and/ or showings. Block 6 is one of the interesting and encouraging blocks. It is the only block which includes a mine in KR, it is an iron mine near Asnawa village.

Recommendations

As a result of this work, the following recommendations have been suggested:

- The mineral investment law in Kurdistan Region should be finalized and approved similar to the Oil Investment Law and the Investment Law of Minerals No. 91 (amended), issued in 1988 to help in attracting foreign investors to come and invest in the mining industry in KR.
- For the time being, and as a temporary measure, the MNR in KR could work according to MOU with any mining company which is willing to invest the announced blocks in KR.
- The establishment of mining engineering educational institutions in KR to help in preparing the necessary skilled manpower to work in the future mining projects efficiently.
- The authorities should work on the removal of all landmines, unexploded ordinances and dangerous items which are thought to be present in some of the mineral wealth fields and locations.
- Some efforts have to be done in order to improve the infrastructure in the potential mining areas.
- An attempt has to be made to raise the level of mining culture within the local community in KR.

Acknowledgements

The authors are very grateful to the Editor in Chief Prof. Dr. Salih M. Awadh, the Secretary of Journal Mr. Samir R. Hijab. and the Technical Editors for their great efforts and valuable comments.

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