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Study of Chromite Mineralogical and Geochemical Characteristics of the Sarsang Region of the Logar Province

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Abstract

A geological and geochemical survey has been conducted in Logar Province, especially in the Sarsing region, to study the chromite condition and mineralogical-chemical characteristics. Field and laboratory methods were used in this study. For the field method, 12 samples have been collected from the area, and the petrographic method has been used to determine the mineralogical characteristics. These slides have been examined in the laboratory of the Geology and Mining Exploration Engineering Department of the Geology and Mining Faculty of Kabul Polytechnic University. Also, the research method of geochemical composition has reached the top using two instruments in the laboratory of the Department of Survey and Geology. namely X-ray fluorescence or Spectro X-Lab Pro. Oxides and minerals in the rocks of hundredths and millionths can be determined and studied using the aforementioned methods.
During mineralogical research, it was found that the composition of the chromite rock was different from the main and secondary minerals. In addition, a geochemical analysis of these rocks revealed that they contain a variety of oxides and elements that have been analyzed.

Keywords: Chromite, XRF, Laboratory, Petrographic, Geochemical

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1. INTRODUCTION

Chrome originates from the Greek word chroma (chroma), which means color. Chromite is one of the oxides, and it is composed of iron-chromium and oxygen. Its chemical formula is ($FeCr_2O_4$). Its color ranges from dark gray to black. It is metallic, and it has a semi-metallic luster and high density. Chromium chloride is 0.0083%, with a high level of 0.2% in extra-alkaline rocks and 0.02% in alkaline rocks. Chromite has a hardness of 5.5 to 7.5 and a specific gravity of 3.6 to 5.1 grams per cubic centimeter, depending on the chemical composition [9].

The ultramafic sections of ophiolitic sequences host a significant number of podiform chromite bodies [4]. The chromite in Afghanistan is primarily found in the Logar and Khost provinces, as well as in the Kandahar and Herat provinces. The mineralization relates to ultramafic rocks, such as serpentinites and dunnites, which are familiar in these areas. The presence of chromite in Afghanistan has been known for decades, and the country has the potential to become a notable player in the global chromite market.

Chromite is widely distributed in Afghanistan, especially in the east and southeast parts of the country. It occurs in Logar, Kabul, Kandahar, Khost, Paktia, Nangarhar, Parvan, and Wardak provinces [3].

Afghanistan is the connection between the Indian and Asian plates and has a complex geology. In Afghanistan, the chromite mines and traces of damascene meta-alkaline exploration are in the hills of the Alp mountains (Logar Wardag Shudal and others). In addition, it has been replaced by prozymites. The ore bodies are placed in the form of lenses in large amounts on the dunes, and the border with the placer rocks is clear. The amount of chromium oxide in ore rocks is 42.4-56% [8].

The general types of ore rocks are checkered, nodular, and mottled, and the structure is medium-grained [2]. The main minerals in the formation include chromite, magnochromite, olivine, spinel, enstatite, magnetite, serpentine, garnet, chrome closet, talc, opal, and chalcedony. Chromite has been used since ancient times in different areas of industry which demonstrates its significance [9].

In the general development of the geological cycle, chromite deposits have been formed twice: during the orogeny phase and the activation of platforms. In the orogeny phase, magmatic deposits have been formed from hyper basics (Dunnites, Harzburgites), among which the magmatic core is more important and is controlled by metasedimentary rock deposits and associated deep faults that have resulted in long chromite-bearing belts, such as the Ural chromite-bearing belts, the Balkans, and Indian-subcontinent. The metallic minerals have a wide, usage area, no branch of industry uses metallic minerals in one way or another [6].

There are currently more than 150 types of metals and non-metals, used directly or semi-processed in the industry, chromite is also related to the class of industrial or industrial technical metals, which is the subject of this research [5].

A lot of industrial factories are dependent on mineral materials. The basic raw materials are made from mineral deposits. In today's era, most mineral materials, namely minerals, and metals, occupy a strategic and political position. Chromite is one of these metals, and it is used in industry on a large scale. It is not produced from chrome, mostly in weapon making, industry, materials that are used at high temperatures, and in other different ways,

as the elements of the platinum group are mostly related to extra-alkaline rocks, and the elements of this group are common. Chromium spin elides have been stabilized in hyperalkaline donates and catalytic donates [8].

This research aims to investigate the chromite mineralogy and geochemical characteristics of the Sarsang area of Logar province. During the laboratory research, it has been found that various minerals are present in the chromite. Also, during the geochemical research, it has been found that most of the elements of Mendeleev's table and various oxides are included in the composition of this chromite. With this, we can determine the origin of this chromite. The significance of the research is to understand the composition of the chromite in the area and to get information about the percentage of various elements.

The U.S. Geological Survey (USGS) and the U.S. Department of Defense Task Force for Business and Stability Operations (TFBSO) engaged in an agreement with the Afghanistan Geological Survey to study and assess the fuel and nonfuel mineral resources of Afghanistan from October 2009 to September 2011, so that these resources could be economically extracted to expand the economy of Afghanistan [3].

2. MATERIALS & METHODS

This study used the descriptive-qualitative method. Data were collected through surveys, interviews, observation, experience, and document studies. Also, to ensure the success of the research, a variety of sources were used. These included books, journals, and special reports. Field and laboratory methods were used to conduct the study then the collected data were analyzed.

2.1 Area Methods

In the area method, Abdullah village area of Sarsang in Logar province and other areas were closely observed. Considering the geological features, 12 samples were taken from the area for analysis. Samples from the area have been taken with the help of a hammer and the Global Positioning System (GPS).

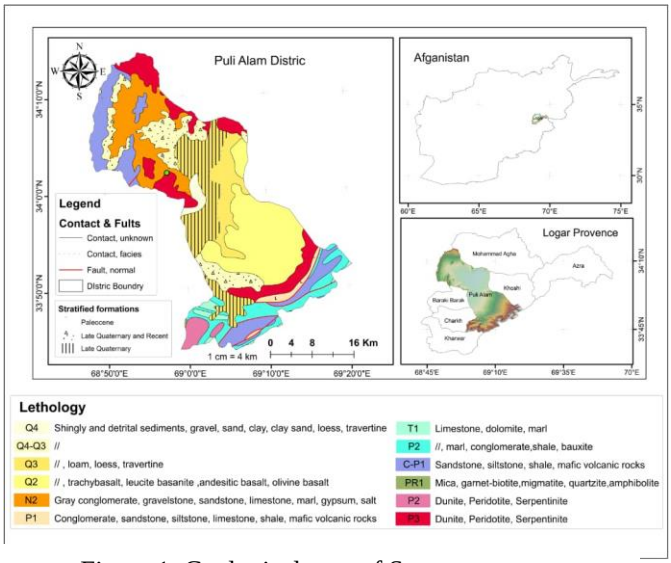


Figure 1: Geological map of Sarsange area

2.2 Laboratory method

The Laboratory Method includes Petrographical Analysis and Geochemical Analysis; these methods are very important for the result of this research. The coal sample is taken from the first petrographic slide, and then each petrographically microscope slide is analyzed. These rock slides were prepared in the Department of Survey and Geology of the Ministry of Mines and Petroleum. Later, it was tested in the Geology and Mining Exploration Engineering Department of the Faculty of Geology and Mining at Kabul Polytechnic University, and related minerals have been accurately identified. The research method for geochemical composition has reached its pinnacle with the assistance of two instruments in the laboratory of the Department of Survey and Geology. These instruments are X-ray Fluorescence and Spectro X-Lab Pro. This method enables the determination of oxides in rocks and the identification of elements down to the one hundred millionth part, as indicated by the study.

An effort has been made as much as possible so that this model can accurately and comprehensively represent the complete cross-section of the chromite in a horizontal and vertical position, thus enabling us to identify the minerals that have made the chromite and investigate the mineralogical and geochemical compositional changes of the rock formations. [1].

3. RESULTS

To find out the petrographic characteristics of this mine, the thin sections of the four collected samples were studied under the petrographic microscope, and the results were analyzed as follows:

Table 1: Geological description of the samples

Sample N	Samples Description			Microscopic Properties	
	Structure	Rock name	Classification	Major	Minor
1	Compact massive	Chromite	Magmatic Ultramaphic	Chromite Olivine	Opec
2	Compact massive	Chromite	Magmatic Ultramaphic	Chromite Olivine	Opec
3	Compact massive	Chromite	Magmatic Ultramaphic	Chromite Olivine	Opec
4	Compact massive	Dolomitic calcite	Sedimentary	Calcite Dolomite Limonite Iron	Chromite Opec

3.1 First sample: This specimen is extracted from the original rock. Based on their mineral composition, chromite and olivine emerge as the predominant minerals, with interspersed metallic minerals within the sub-minerals. The structure of this sample is compact and massive. Macroscopic examination reveals that the rock originates from ultramafic magmatism.

3.2 Second Sample: The sample consists mainly of chromite and olivine. Chromite and olivine are the primary minerals present, with subsidiary minerals occupying certain spaces. The structure is compact and massive. Macroscopically, the rock is determined to have an ultramafic magmatic origin.

3.3 Third Sample: This sample has a brownish-black color and is predominantly composed of chromite and olivine minerals. Secondary minerals are also present in certain areas. The structure is compact and massive, with a grainy texture. Macroscopically, it is determined to have an ultramafic magmatic origin.

3.4 Fourth Sample: This sample has been extracted from sedimentary deposits, and its color is brownish-yellow. The main minerals include calcite, dolomite, and limonite, while secondary minerals consist of chromite and spinel. Its origin is sedimentary, characterized by carbonate deposits.

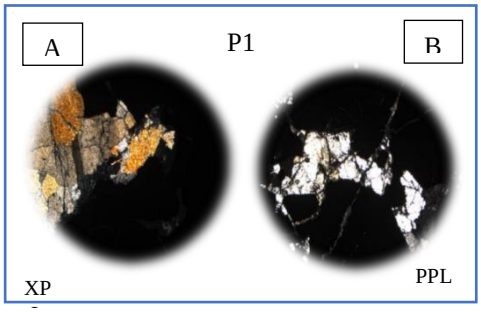


Figure 2: P1 sample photo and mineral assemblage under a microscope

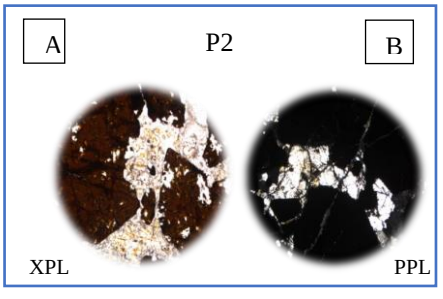


Figure 3: P2 sample photo and mineral assemblage under a microscope

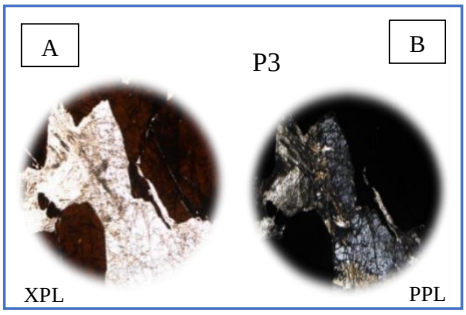


Figure 4: P3 sample photo and mineral assemblage under a microscope

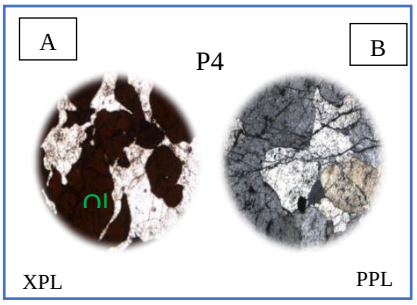


Figure 5: P4 sample photo and mineral assemblage under a microscope

Geochemistry Analysis: The results of the table below

Table 2: The XRF result of the various oxides in the Chromite of Loger province Sarsang area.

Oxides %	Number of samples											
	1	2	3	4	5	6	7	8	9	10	11	12
MgO	0	0	2.10	0	1.986	3.404	42.003	22.67	24.10	19.76	44.73	0
Al_2o_3	0.16	0.14	0.77	0.33	0.876	0.591	7.482	2.279	24.34	2.846	4.606	0
Sio_2	2.08	3.74	2.93	3.92	3.090	2.289	68.660	56.85	6.715	60.63	73.92	2.270
Fe_2o_3	6.38	1.21	20.1	3.11	6.694	6.389	9.388	8.446	13.00	7.921	3.646	6.132
Cr_2o_3	0.25	0.63	0.90	4.83	47.76	18.90	10.115	8.472	39.84	15.47	1.257	0.093
Cao	0.71	2.10	0.90	4.45	1.639	3.860	2.162	1.233	0.283	0.668	0.972	0.321
Tio_2	0	0.00	0.05	0.03	0.42	0.044	0.035	0.055	0.121	0.059	0	0.008
K_2o	0	0	0	0	0	0	0.170	0.144	0.268	0.070	0.055	0
So_3	0.16	0.32	0.25	0.32	0.267	0.226	0.598	0.344	0	0.374	0.455	0.184
P_2o_5	0.09	0.81	0.14	0.20	0.197	0.150	0	0	0.321	0	0	0.175

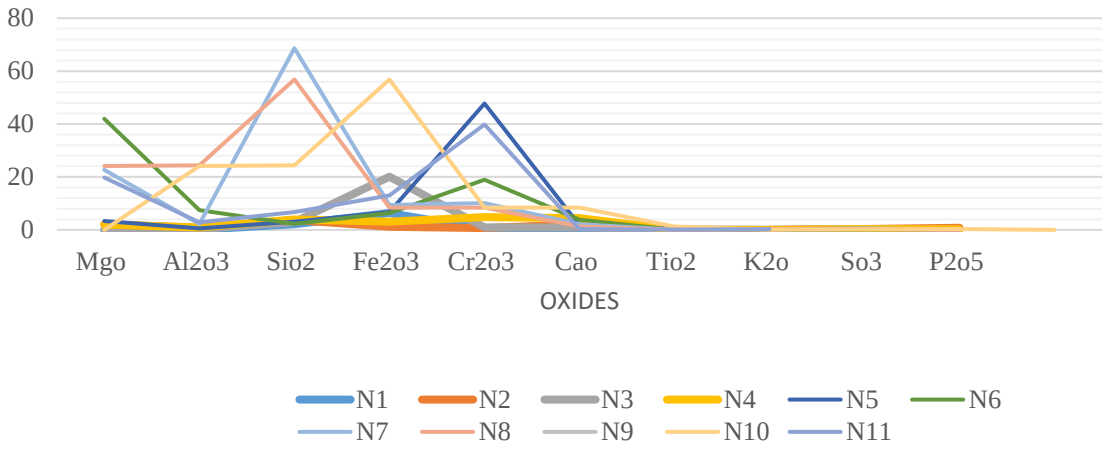


Figure 6: Showing the percentage of the oxides in chromite

Table 3: Shows the element's percentage in the Logar province Sarsag area chromite:

Element %	**Number of samples**											
	1	2	3	4	5	6	7	8	9	10	11	12
Bal	93.23	93.99	75.31	87.89	79.44	75.339	21.8632	44.30	32.139	40.53	31.250	93.691
Mg	<LOD	<LOD	<LOD	<LOD	1.196	5.0411	25.303	13.661	14.523	11.905	26.550	<LOD
Al	<LOD	0.221	0.408	<LOD	0.463	0.3031	3.9590	0.148	12.88	.1506	24.37	<LOD
Si	0.973	17.51	1.37	1.834	1.573	1.0739	32.084	26.565	13.8	28.335	34.345	1.060
P	0.043	0.073	0.062	0.089	0.086	0.0658	28.335	<LOD	<LOD	<LOD	<LOD	0.076
S	0.064	0.13	0.10	0.129	0.107	0.0906	0.239	0.137	0.107	0.1498	<LOD	0.073
Cl	0.131	0.20	0.186	0.216	0.193	0.1798	0.336	0.176	0.097	0.206	0.182	0.136
K	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	0.140	0.179	0.122	0.058	0.263	<LOD
Ca	0.509	1.50	0.646	3.184	1.171	2.7573	1.544	0.881	0.2023	0.477	0.045	0.229
Ti	<LOD	<LOD	0.033	0.018	0.025	0.0266	0.021	0.332	0.072	0.035	<LOD	<LOD
V	0.007	0.019	0.089	0.016	0.034	0.0492	0.023	0.025	0.093	0.033	0.010	0.0071
Cr	0.173	11.6	13.79	3.313	10.13	12.945	6.928	5.803	27.289	10.602	0.861	0.0643
Mn	0042	0.021	0.391	0.345	0.622	0.0703	0.380	0.476	<LOD	0.81	0.084	0.083
Fe	4.462	0.851	6.065	21.75	4.681	4.4660	6.665	5.090	9.093	5.539	2.548	4.288
Co	0.018	0.013	0.083	0.031	0.071	0.0520	<LOD	<LOD	0.0033	0.029	<LOD	0.032
Ni	0.020	0.091	0.135	0.482	0.167	0.1337	0.548	0.526	0.148	0.268	0.439	0.195
Cu	0.003	0.006	0.006	0.005	0.008	0.2714	<LOD	<LOD	0.006	<LOD	<LOD	<LOD
Zn	0.004	0.004	0.078	0.022	0.0132	0.025	0.011	0.029	0.015	0.04	0.021	0.0039
As	0.0005	<LOD	<LOD	0.0006	<LOD	<LOD	<LOD	0.0007	<LOD	0.001	0.0009	0.0005
As	<LOD	0.029	0.005	0.0027	0.001	0.0017	0.035	0.001	0.0002	0.0002	0.0006	0.00095
Zr	<LOD	0.0003	0.005	0.0004	0.005	<LOD	0.004	0.0003	<LOD	<LOD	0.0004	<LOD
Nb	<LOD	0.0005	0.0006	0.0006	0.0006	<LOD	0.006	0.0004	0.0006	0.0003	0.0006	<LOD

4. DISCUSSION

As a result of comparing the petrographic and geochemical analyses of both methods, the following results were obtained:

All the mineral samples analyzed under the microscope are non-mineral in composition, i.e., it has chromite and olivine in its composition; these types of rocks belong to the first category. From the petrographic tests, it is concluded that in the samples taken from the

original rocks, the main minerals are chromite and olivine, the secondary minerals are opacs, and the ultramafic magma is of volcanic origin.
In addition, after analyzing the samples of the placer rocks that made up the slide, it was found that calcite, dolomite, iron, and limonite are among the main minerals, and chromite and opac are among the minor minerals. Also, its origin is sedimentary, and carbonate was selected.
Therefore, the samples on which the XRF analysis was implemented contained less than 0.5% of several elements such as sulfur, phosphorus, potassium, cobalt, nickel, silicon, and others, which are very small. From the results of the geochemical analysis, the percentage of chromite oxide reaches 47.76 in some samples, which may increase further with increasing depth, which indicates the high quality and high percentage of chromite.

5. CONCLUSION

There was a need to examine the mineralogical and geochemical characteristics of chromite in the Sarsang region of Logar province to analyze the mineral composition and the possible presence of some elements in these rocks because of the research. Hence this study was conducted to investigate the mineralogical and geochemical characteristics. The results of the XRF analysis showed that in some samples, chromite oxide was present in a high percentage. It is concluded that the high percentage of chromite oxide in these stones indicates that it has a high quality. Consequently, the mine will have an increase in its economic value, which can help play a beneficial role in the country's economy in the long run. It is seen from laboratory research that nickel and cobalt are also present in chromite minerals, and these stones should be evaluated based on the content of these elements as well.

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Disclosure statement
The authors declare that there is no potential conflict of interest.

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